QPX1200

DC Power Supply

Service Manual

Manual Part Number 48511-1130 Issue 1

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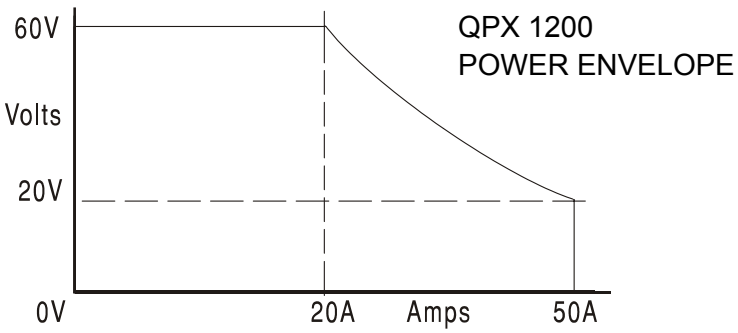
Specification

General specifications apply for the temperature range 5°C to 40°C. Accuracy specifications apply for the temperature range 18°C to 28°C after 1 hour warm-up with no load and calibration at 23°C. Typical specifications are determined by design and are not guaranteed.

OUTPUT SPECIFICATIONS

Voltage Range:	0V to 60V
Current Range:	0.01A to 50A
Power Range:	Up to 1200W
Voltage Setting:	Resolution 1mV Accuracy: 0.1% of setting ± 2mV
Current Setting:	Resolution 10mA Accuracy: 0.3% of setting ± 20mA
Operating Mode:	Constant voltage or constant current with automatic cross-over provided that the power demanded stays within the power envelope, see graph. Outside of this envelope the output becomes unregulated. CV, CI or UNREG mode indication in display.



Output Switch:	Electronic, with ON indication. Preset voltage and current displayed when off.
Output Terminals:	Front panel safety terminals accepting 6mm wire diameter, 6mm plugs or 8mm spades at 50 Amps max, or 4mm plugs at 30 Amps max. Duplicate rear panel terminals.
Sensing:	Switchable between local and remote. Screwless remote sense terminals on both front and rear panels. Sense miswiring trip and indication.
Ripple & Noise (20MHz bandwidth):	Typically <3mVrms, <20mV pk-pk at maximum load, CV mode
Load Regulation:	Change in output for any load change within PowerFlex envelope, using remote sense: Constant voltage: <0.01% ± 5mV
Line Regulation:	Change in output for a 10% line change: Constant voltage: <0.01% ± 5mV
Transient Response:	<250us to within 100mV of set level for a 5% to 95% load change.
Output Protection:	Output will withstand an applied forward voltage of up to 70V. Reverse protection by diode clamp for reverse currents up to 3A.

Over-voltage Protection (OVP):	Range 2V to 65V. Resolution 0.1V; accuracy: 0.2% ± 0.2V. Response time typically 100μs.
Over-current Protection (OCP):	Range 2A to 55A. Resolution 0.1A; accuracy: 0.5% ± 0.2A. Response time typically 100ms.
Over-temperature Protection:	The output will be tripped off if a fault causes the internal temperature to rise excessively.
Temperature Coefficient:	Typically <100ppm/°C

METER SPECIFICATIONS

Display Type:	5-digit (Volts), 4-digit (Amps), black-on-white backlit LCD.
Voltage (CI Mode and Unreg):	Resolution 1mV Accuracy: 0.1% of reading ± 2 digits
Current (CV Mode & Unreg):	Resolution 10mA Accuracy: 0.3% of reading ± 2 digits
V x A:	Resolution 0·1W Accuracy: 0·5% ± 0·1W

LOGIC CONTROL INPUT and OUTPUT

LOGIC IN is a rear-panel opto-isolated input that is activated at an input current greater than approximately 1mA. User can set LOGIC IN (via the keyboard) to enable the output, disable the output, or be ignored when it is activated.

LOGIC OUT is an isolated rear-panel open-collector output that will sink up to 2mA when activated ('switch closure'); the maximum voltage that can be applied to LOGIC OUT is 30VDC. User can set LOGIC OUT to be 'closed' or 'open' for output enabled or disabled, current limit (CI mode), power limit (UNREG mode), or for any fault trip.

ANALOG REMOTE CONTROL and MONITORING

Non-isolated inputs and outputs to set voltage and current limit and to monitor actual output voltage and current. These signals are referenced to the positive output and have a range of 0 to 10V or 0 to 5V (selectable via the keyboard).

Analogue Control Accuracy:	Voltage: 0.3% ± 4mV; Current: 0.5% ± 40mA
Analogue Monitor Accuracy:	Voltage: 0.3% ± 4mV; Current: 0.5% ± 40mA

KEYBOARD & ROTARY CONTROL

All functions, including the selection and set-up of the remote control interfaces, can be set from the keyboard. The rotary Jog control can be used to adjust output voltage and current settings in a quasi-analogue mode.

DISPLAY FEATURES

The display is a 240 x 64 pixel transflective LCD, backlit by white LEDs; contrast is software-controlled and can be adjusted from the keyboard.

The default status display shows the VOLTS (5 digits) and AMPS (4 digits) in 10mm high characters, plus the present output mode. At other times, for example during store or recall of instrument set-ups, the display shows up to 6 lines of information, instructions, or prompts.

INTERFACES

Full digital remote control facilities are available through the RS232 and USB interfaces. Setting and readback resolutions are the same as the Output and Meter specifications respectively.

RS232:	Variable Baud rate, 19200 Baud maximum. 9-pin D-connector. Single instrument or Addressable RS232 operation.
USB:	Standard USB 2.0 hardware connection.
Remote Command Processing Time:	Typically <100ms between receiving the command terminator for a step voltage change at the instrument and the output voltage beginning to change.

GENERAL

AC Input:	110V – 240V AC ± 10%, 50/60Hz. Installation Category II.
Power Consumption:	1600VA max.
Operating Range:	+5ºC to +40ºC, 20% to 80% RH.
Storage Range:	–40ºC to + 70ºC.
Environmental:	Indoor use at altitudes up to 2000m, Pollution Degree 2.
Store/Recall:	Up to 10 set-ups can be saved and recalled via the keyboard or remote interfaces.
Safety:	Complies with EN61010-1.
EMC:	Complies with EN61326.
Size:	130mm H (3U) x 356mm W x 413mm D
Weight:	9.2kg
Options:	19-inch rack kit.

This instrument has been designed to meet the requirements of the EMC Directive 89/336/EEC.

Compliance was demonstrated by meeting the test limits of the following standards:

Emissions

EN61326 (1998) EMC product standard for Electrical Equipment for Measurement, Control and Laboratory Use. Test limits used were:

a) Radiated: Class A

b) Conducted: Class A

c) Harmonics: EN61000-3-2 (2000) Class A; the instrument is Class A by product category.

Immunity

EN61326 (1998) EMC product standard for Electrical Equipment for Measurement, Control and Laboratory Use.

Test methods, limits and performance achieved were:

a) EN61000-4-2 (1995) Electrostatic Discharge : 4kV air, 4kV contact, Performance A.

b) EN61000-4-3 (1997) Electromagnetic Field, 3V/m, 80% AM at 1kHz, Performance B.

c) EN61000-4-11 (1994) Voltage Interrupt, 1 cycle, 100%, Performance B.

d) EN61000-4-4 (1995) Fast Transient, 1kV peak (AC line), 0·5kV peak (DC Outputs), Performance B.

e) EN61000-4-5 (1995) Surge, 0·5kV (line to line), 1kV (line to ground), Performance B.

f) EN61000-4-6 (1996) Conducted RF, 3V, 80% AM at 1kHz (AC line only; DC Output connections <3m not tested), Performance B.

According to EN61326 the definitions of performance criteria are:

Performance criterion A: 'During test normal performance within the specification limits.'

Performance criterion B: 'During test, temporary degradation, or loss of function or performance which is self-recovering'.

Performance criterion C: 'During test, temporary degradation, or loss of function or performance which requires operator intervention or system reset occurs.'

Where Performance B is stated it is because DC Output regulation may deviate beyond Specification limits under the test conditions. However, the possible deviations are still small and unlikely to be a problem in practice.

Note that if operation in a high RF field is unavoidable it is good practice to connect the PSU to the target system using screened leads which have been passed (together) through an absorbing ferrite sleeve fitted close to the PSU terminals.

Cautions

To ensure continued compliance with the EMC directive observe the following precautions:

a) after opening the case for any reason ensure that all signal and ground connections are remade correctly and that case screws are correctly refitted and tightened.

b) In the event of part replacement becoming necessary, only use components of an identical type, see the Service Manual.

Safety

This power supply is a Safety Class I instrument according to IEC classification and has been designed to meet the requirements of EN61010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use). It is an Installation Category II instrument intended for operation from a normal single phase supply.

This instrument has been tested in accordance with EN61010-1 and has been supplied in a safe condition. This instruction manual contains some information and warnings which have to be followed by the user to ensure safe operation and to retain the instrument in a safe condition.

This instrument has been designed for indoor use in a Pollution Degree 2 environment in the temperature range 5°C to 40°C, 20% - 80% RH (non-condensing). It may occasionally be subjected to temperatures between +5°C and –10°C without degradation of its safety. Do not operate while condensation is present.

Use of this instrument in a manner not specified by these instructions may impair the safety protection provided. Do not operate the instrument outside its rated supply voltages or environmental range.

WARNING! THIS INSTRUMENT MUST BE EARTHED

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited. The protective action must not be negated by the use of an extension cord without a protective conductor.

When the instrument is connected to its supply, terminals may be live and opening the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts. The apparatus shall be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance or repair.

Capacitors inside the power supply may still be charged even if the power supply has been disconnected from all voltage sources but will be safely discharged about 10 minutes after switching off power.

Any adjustment, maintenance and repair of the opened instrument under voltage shall be avoided as far as possible and, if inevitable, shall be carried out only by a skilled person who is aware of the hazard involved.

If the instrument is clearly defective, has been subject to mechanical damage, excessive moisture or chemical corrosion the safety protection may be impaired and the apparatus should be withdrawn from use and returned for checking and repair.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders is prohibited.

Do not wet the instrument when cleaning it.

The following symbols are used on the instrument and in this manual:-

Earth (ground) terminal.

mains supply OFF.

mains supply ON.

alternating current (ac)

direct current (dc)

Service Handling Precautions

Service work or calibration should only be carried out by skilled engineers using high quality test equipment. If the user is in any doubt as to his competence to carry out the work, the instrument should be returned to the manufacturer or their agent overseas for the work to be carried out.

The tracks on the printed circuit boards are very fine and may lift if subjected to excessive heat. Use only a miniature temperature-controlled soldering iron and remove all solder with solder wick or suction before attempting to remove a component.

Dismantling the instrument

WARNING!

Disconnect the power supply from all voltage sources before it is opened for adjustment or repair. Capacitors inside the supply may still be charged even if the supply has been disconnected from all voltage sources but will be safely discharged about 10 minutes after removing power.

If any adjustment or repair of the opened supply under voltage is inevitable it shall be carried out only be a skilled person who is aware of the hazard involved. The incoming AC supply to the unit under test should be isolated for safety by means of a 1:1 isolation transformer of at least 1500VA.

High voltages (up to 400V) are always present in the primary-side circuits on both the PFC board and Power board; on the Power board the primary side occupies a clearly defined area at the rear of the board.

1. Remove the 4 side screws to release the top cover.
2. To gain access to the Control PCB and Keyboard, release the front panel assembly from the chassis by removing the 2 M3 side nuts, the countersunk M3 screw securing the top bracket, and the 4 M3 screws (with integral shakeproof washers) along the bottom edge.
3. *Keyboard:* Remove the 5V supply from PJ4, the 4 connections to the mains switch, and the 3-way connections to the Control (PJ10) & Interface (PJ9) boards. The Keyboard is released from the front panel by removing the 7 screws which secure it.
4. *Control:* Remove the 10-way connector (PJ100) to the Power board, noting polarity (corner marker to pin1); remove the flat cable connection to PJ101 and the 3-way connection to the Keyboard (PJ105). Remove the nuts which secure the front and rear output connecting cables from the terminals on the front panel/Control board after noting their positions. To release the Control board remove the 3 M3 screws to the front panel plus the 3 nuts which secure it directly to the +, –, & earth terminals. When re-assembling do not forget the brass bus-bar between the Red output terminal and the current measurement shunt connection.
5. *PFC:* Remove the 5V supply to the Keyboard (at PJ2) and the mains connections at W1, W2, W3 &W4; when reassembling note that W1 & W4 (to the front panel switch) share a ferrite sleeve and W2 & W3 (return from the switch) share a ferrite sleeve. Remove the 4-way primary AUX connection at PJ1 (note the position of ferrite sleeve at the Power board end of the connection) and the HT connection at FAS5, FAS6 & W5. To release the PFC board from the chassis remove the 9 M3 screws (with integral shakeproof washer) from the **underside** of the chassis, leaving the support pillars attached to the board assembly. Ease the board forward a little in the chassis, so that the safety earth connection to the rear panel can be undone, and lift the board free.

6. *Power:* Remove the 10-way connector (PJ5) to the Control board, noting polarity (corner marker to pin1); remove the flat cable connection to PJ4 at the rear of the board; remove the HT connection from the PFC board at FAS1 & FAS2; remove the 4-way primary AUX connection from the PFC board at PJ1; remove the 3 2-way fan power connections (PJ6,PJ7, PJ8); remove the 2 M6 barb nuts which secure the output cables to the front panel. To release the Power board from the chassis it is first necessary to remove the 3rd, internal, fan; push out the centres of the 2 plastic push-rivets which secure the top of the fan to the bracket and lift out the fan with its lower bracket still attached. When re-assembling note that the fan label faces the transformer (airflow towards the transformer). Remove the 10 M3 screws (with integral shakeproof washer) from the **underside** of the chassis, leaving the support pillars attached to the board assembly, and lift the assembly forward and up.

7. *Interface:* Remove the 3-way connection to the Keyboard at PJ3. The Interface board is secured only by the RS232 screwjacks; undo these to release the board.

8. When reassembling, take great care to ensure that all connections are exactly as before dismantling and that no insulation creepage and clearance distances have been compromised. Ensure that only the correct fasteners have been used otherwise earthing, and hence EMC and safety performance, may be impaired.

PFC Board

Mains Input, Filtering and Rectification

The AC input is via PJ3, a pcb mounted IEC plug, and fuse FS1.

X-capacitors C1, C4, C7, C10 & C68, together with the Y-capacitors C5, C6, C11 & C12, common mode inductors L1, L2 & L3 and differential inductors L4 & L8 comprise an input filter which ensures that the supply meets both conducted emission and conducted immunity EMC requirements.

VD1 clips mains spikes for component protection, while R1 discharges the X-capacitors after removal of the mains supply.

Pcb mounted fuse FS1 limits damage on boost-stage or forward converter failure. The front panel mains switch is connected via connectors W1, W2, W3 and W4.

The bridge rectifier comprised of D1, D2, D3 and D4 has C13 and C14 connected across it to bypass noise signals and to snub reverse recovery transients in the bridge rectifier.

C15, C16 further decouple the input filter and rectifier from the boost converter.

R2 limits the initial inrush current into the boost stage output capacitors C19 and C20 and is by-passed by relay PL1 once the boost converter starts.

Auxiliary Supplies

Primary Side

The primary auxiliary supplies are generated by IC5. This is a 7 pin TO220 style device which incorporates the control circuitry and power switch to implement an off line flyback power supply. It derives its power from the boosted HT rail.

R93 sets the power switch peak current to 0.4A. D20, R55 and C47 clamp the drain voltage of the power switch at a safe level. The low voltage output of transformer T9 is peak rectified by D21 and C49 . The output voltage is regulated to 24V by zener diode D22 and feedback to the control pin is via opto coupler IC15. The 24V rail powers the fans.

IC6 generates an 18V rail for the PFC control IC4.

IC7 generates a 15V rail for the power pcb primary control circuit.

Secondary Side

A 5V supply for the front panel keyboard is generated by IC9. This is an 8 pin SMD style device which incorporates the control circuitry and power switch to implement an off line flyback power supply.

It derives its power from the AUX_HT line, which is generated by D36, D37 and C81, C37. This rail is decoupled from the HT boost rail. When the mains supply is switched off, this AUX_HT rail falls quickly and the front panel display vanishes very rapidly.

Start-up Control Circuit

D23 and R58 provide a 5.1V reference voltage to the negative inputs of all 4 op-amps of IC8.

When the mains is switched on, potential divider R59, R59B, R60, R60B and R61 feeds the attenuated full wave rectified mains voltage to the positive input of IC8-A.

The bulk storage capacitors C19, C20 are being charged via inrush current limiting resistor R2.

When the mains voltage exceeds approximately 80Vrms, the output of IC8A begins to produce pulses, which charge C21 via D24. When the mains voltage reaches approximately 87Vrms, the voltage on C21 exceeds the reference voltage on IC8-B negative input and the output of IC8-B goes high, charging C55,C56 via R67.

After a delay of about 0.4s, the voltage on C55, C56 exceeds the reference voltage on IC8-C negative input and the output of IC8-C goes high, turning on Q8 via D29 and R74 thus energising RL1 which bypasses the current inrush resistor R2.

The output of IC8-C also charges C58 via R70 thus producing a short delay before the output of IC8-D goes high and turns on Q9 which in turn switches Q10 and Q11 off. When Q11 goes off, the SS signal is no longer clamped to 0V and allows the PFC control IC4 to start up.

When the mains voltage is switched off, C21 is no longer supplied with top-up pulses and is discharged by R64. IC 8-B output goes low and quickly discharges C55, C56 via D25. IC8-C output then goes low and immediately turns off Q9 via D28. This causes Q11 to come on, clamping the SS signal to 0V and stopping the PFC control IC4.

IC8-B output going low, discharges C58 via R71 and D26, thus providing a short delay before IC8-D output goes low and switches off the bypass relay driver Q8.

The above timing sequences ensure that the inrush relay RL1 contacts only switch under zero load conditions.

Primary Boost stage Control circuit

The primary boost stage control is by means of IC4.

This contains all the processing circuitry to shape the current taken by the power supply from the mains supply to be sinusoidal and in phase with the voltage.

For a detailed description refer to the ST ‘Power Factor Corrector Applications Manual‘.

When the mains is switched on, the +18V supply to IC4/pin19 is established and IC4 becomes active after a short delay when the SS signal is released by the start-up control circuit. During this short delay the bulk storage capacitors C19, C20 are charged via the inrush-limiting resistor R2.

IC4 starts up and supplies drive pulses to the gate ICs IC1, IC2, IC3, which drive the gates of the boost MOSFETs Q1, Q2, Q3, Q4, Q5, Q6.

C44 is connected to the soft start pin of IC4 and provides a soft start.

R34, R34b, R35, R35b, R37, C35, C35b, C36, C36b form a two stage RC filter to feed a voltage proportional to the mains voltage to IC4/pin 7 which, after an internal $1/V^2$ transformation, is fed to the internal multiplier. For a universal mains input, the voltage at this pin will vary between 1.5V and 5.5V.

R38+R38a and R39+R39a supply a current derived from the full wave rectified mains voltage to IC4/pin 4 to be used by the internal multiplier.

Also fed to the internal multiplier is the output of the voltage error amplifier of IC4/pin 13. The input to the error amplifier at pin 14 is from potential divider R41, R41b, R42, R42b, R62, R63 and VR1.

This potential divider monitors the voltage on the boost stage output capacitors C19, C20 and this is compared to an accurate internal reference voltage. Thus a steady voltage of about 395V, as set by VR1, is maintained across C19, C20.

Another potential divider R44, R44b, R45, R45b, R46 monitors the voltage across C19, C20 and feeds into pin 3 of IC4 which is the over-voltage shutdown. C80 slows the signal going into the over-voltage pin to prevent the over-voltage circuit from activating during transient load changes.

Pin 8 is the output of the multiplier and is the programming current for the internal current error amplifier. This signal is taken to the mains supply side of the current sense resistor R52 via R48. The other input of the current error amplifier is taken to the other side of R52 via R50. The current error amplifier thus compares the signal across the current sense resistor R52 with the programming current and adjusts the PWM drive to the boost MOSFETs accordingly.

R49 and C42 with R50 form the compensation network around the current error amplifier.

Boost Stage

Three boost inductors L5, L6, L7 are each driven by a pair of MOSFETs Q3+Q6, Q2+Q5, Q1+Q4 respectively to raise the incoming, full wave rectified, sinusoidal mains voltage to a value some 30V higher than the peak of the maximum rms input voltage. This is achieved by storing energy in the boost inductors when the MOSFETs are conducting and transferring it to C19, C20 via boost diodes D5, D6, D33 when the MOSFETs are turned off.

When the MOSFETs turn on, the boost diodes D5, D6, D33 are still conducting current. To prevent large switch on losses, delay inductors L9, L10, L11 are placed in series with the MOSFETs. This ensures that the current in the boost diodes is reduced at a gradual rate and the reverse recovery time is minimised at the same time as the drain voltage of the MOSFETs is allowed to fall rapidly.

The energy stored in L9, L10, L11 is transferred to C18, C61, C62 via D19, D7, D8 and dissipated in R23, R6, R9.

Snubber networks C22, R15, R19, C23, R16, R21, C24, R18, R22 reduce switch-off losses in the MOSFETs.

The main boost heatsink is protected against excessive temperature by PTC2, IC12 and associated components; once triggered it is necessary to turn the mains power off and on again to restart.

Power Board

Forward Converter

The 400V HT supply from the PFC board is connected to the Power board via FAS1 and FAS2 and decoupled by C2.

C1 and C3 with their respective bleed resistors R149 and R150 form the voltage divider to feed the converter transformer T1 of the half bridge forward converter.

The half bridge configured power MOSFETs Q28 and Q29 are connected to the converter transformer T1 via the current transformer CT1 and ZVS inductor L2 and operate at a fixed duty cycle of about 42% at a switching frequency of 73kHz. See the gate drive waveform in Photograph1.

C4 and C12 work with L2 to facilitate zero voltage switching for Q28 and Q29.

R11, C16 and FB3 damp high frequency ringing across T1 primary. See photograph 02.

The gate drive pulses for Q28 and Q29 are generated by oscillator IC2-B/IC2-C feeding into IC3-A to produce complimentary square waves at IC3-A pins 1 and 2.

The leading edges of these anti-phase square waves are slowed by R39/C37 and R42/C38 and buffered by IC2-A,E,D,F to produce anti-phase pulse trains of the correct duty cycle to drive the gate drive transformer T3 via Q13, Q15, Q17, Q18 and C35. The supply to the gate transformer drivers is decoupled by C17, C28, C29, C30. The gates of Q28 and Q29 receive their anti-phase drive from the secondaries of T3 via R52 and R73 and respective anti parallel diodes D1 and D2.

The output of the current transformer CT1 is full wave rectified by D16, D17, D22, D23 and loaded with burden resistor R26. The voltage developed across R26 is utilised by two different circuits.

The first is to turn on Q11 via zener diode D27 when the current in the primary power switches exceeds a certain value determined by R157 and R158. Q11 collector charges C26 negatively via R21. When the voltage across C26 exceeds a threshold set by zener diode D10, latch Q9, Q14 turns on and pulls signal SDWN down to the P0V rail via D20. This in turn causes the power factor correction circuit to shut down – requiring the removal of the mains supply in order to restart. This would only happen under repeated short-circuiting of the output. Q9, Q14 latch can also be activated by the signal OPTO1 via R102 – as would be the case when the voltage on the secondary exceeds a value set by zener diode D5. The primary heatsink is protected against excessive temperature by PTC TH3 which turns on Q16 and this in turn activates latch Q9, Q14.

The voltage developed across R26 is also utilised to regulate the fan speed. As the secondary loading increases, the voltage across R26 is peak detected by D50 and C31 and sets a demand

voltage level at the positive input of op-amp IC14-A, the output of which turns on fan drive transistor Q38. The fan current is monitored by R120, R121 and amplified by IC14-B to provide negative feedback to the negative input of IC14-A.

Secondary Side

The main secondary winding is centre tapped and terminates on pins 19/20, 15/16 with the centre tap on 17/18.

Snubber networks R7, C13 and C14, R18 across each half reduce high frequency ringing.

D47 and C80 generate a negative rail which bleeds a negative current from the output via resistors R131 and R132.

The voltage on the secondary winding is rectified by D47 & D11, L-C filtered by L1, C5, C7, C8, C11 with flywheel diodes D6 & D7, and fed to a linear output stage comprised of MOSFETs Q3, Q4, Q5, Q6. To minimise power dissipation in the linear output stage, the voltage across the MOSFETs is monitored by error amplifier IC7-A (Sheet 2) which maintains the voltage across the linear output MOSFETs to below 1V by adjusting the 'Control' signal to the synchronous post regulator MOSFETs drive circuit (Sheet 3).

The synchronous post regulator MOSFETs Q2 and Q8 regulate the voltage across the linear output MOSFETs by initially blocking the pulse from the secondary winding and only conducting after a delay determined by the 'Control' signal.

Referring to Sheet 3, the drive to the post regulator MOSFETs is generated by two identical circuits operating in anti-phase.

An auxiliary centre tapped winding on the converter transformer T1 terminated on pins 21, 22, 23, and 24 generates the V+SEC and –8VSEC rails for the secondary control circuitry and also the reference pulses AAA and BBB for the post regulator control circuit.

This description refers to the upper channel on sheet 3.

The reference pulse AAA is buffered and squared by AND gate IC10-B. The output of the AND gate charges and discharges capacitor C58 via R66. The discharge time is shorter due to R69 and D41 conducting. The resultant triangular waveform is shown in photograph 03.

The long tail pair (LTP) comparator Q22 & Q23 switches when the triangle waveform at Q23 base exceeds the reference voltage on Q22 base. The 'Control' voltage from IC7-A is fed to the base of Q21 via R75 and VR3. The pulse width of the two sides is balanced by adjusting VR3.

Q21 emitter sets a pedestal level from which the charging of C58 begins.

The higher this pedestal level, the quicker C58 charges to the reference level on Q22 base and the LTP comparator switches. This in turn switches Q20 which delivers a pulse to AND gate IC10-D where it is gated with the AAA reference signal, the trailing edge of which has been slightly delayed by R71 and C59.

The output of the AND gate IC10-D drives a MIC4428 driver IC, the antiphase outputs of which drive the gate of the synchronous post regulator MOSFET Q2 via gate drive transformer T4.

Photograph 04 shows the triangular signal at the base of Q23 together with the pulse at IC10-D pin 9. The reference voltage at the base of Q22 is coincident with the X-axis in the centre of the oscilloscope screen.

To avoid uncontrolled post regulator conduction, Q32 and associated components ensure that the 'Control' signal is clamped to 0V during initial power-up.

The constant power limit is realised using analogue multiplier IC6.

The output voltage and output current are monitored by IC5-A and IC5-B respectively and the resultant signals fed to the Y and X inputs of the analogue multiplier. The output of the multiplier is of the form (X*Y)/10 +Z.

Z is a third input and is used to modify the power limit to give a lower power limit at high output current. The correction signal is generated by IC15-B.

The signal across the current sense resistors R12, R13, R14 and R15 is fed into pin5 of IC15-B. With the output current set to 20A, the signal at pin 5 is nulled by the current in R91/VR4 from the negative voltage generated by zener D49. The null point setting is aided by comparator IC15-A which drives two LEDs, the null being achieved when both LEDs are off .

Having nulled the voltage generated by the 20A output current in the current sense resistors, the increasing current generates a voltage at the output of IC15B and this is fed to the Z input of the analogue multiplier. The required level of correction is set by VR5.

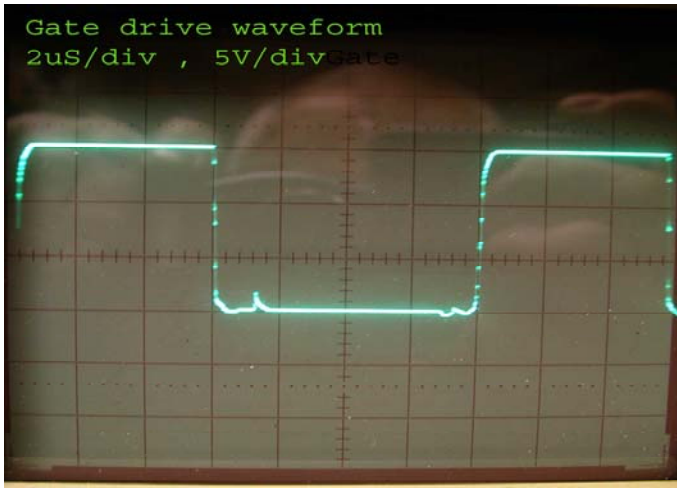
The supply rails for the front panel control circuit are generated from an auxiliary winding on the converter transformer T1 terminated on pins 13 and 14.

A V+ rail of approximately 10V is generated by D33, D34 and filter L4, C40.

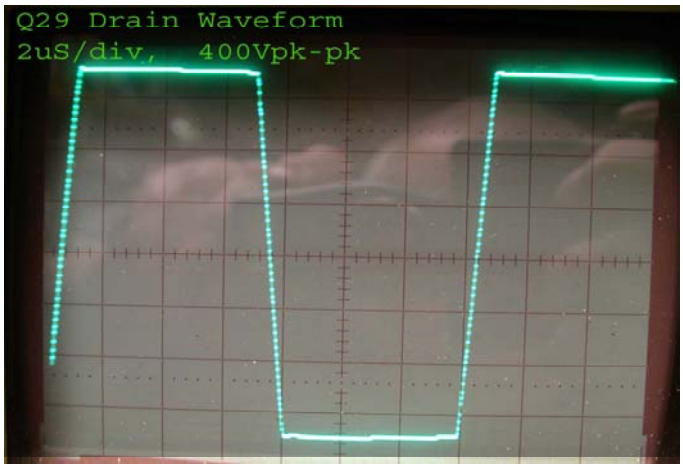
A +15V rail is generated by D35, C43, R51 and D36.

A -8V rail Is generated by D38, C44, R55 and D37.

Photograph 1

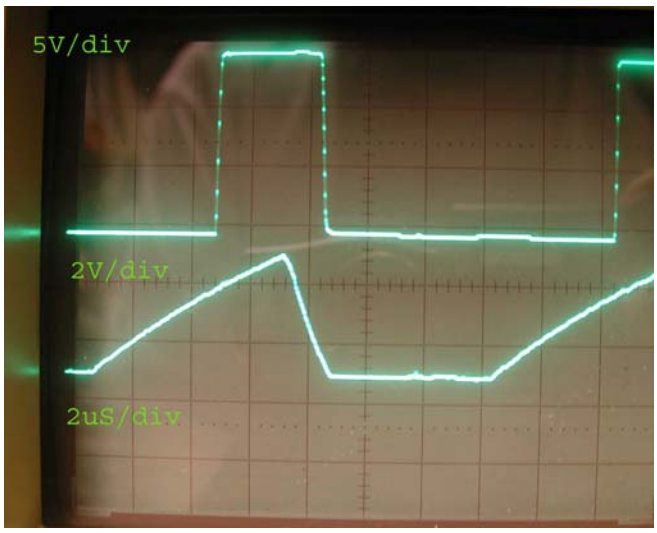


Photograph 2



Photograph 3

Photograph 4



Control Board

The control board contains an ARM7 processor, IC111, programmed via JTAG header PJ103. The three processors communicate via a shared bus but in this case it is isolated via opto-couplers IC109 and IC110.

The board needs several power supplies and, with the exception on the '-8V' and '+15V' rails, these are all derived from the 'V+' rail generated on the Power board and connected to the Control via PJ100. IC117 generates a 5-volt rail, which is used to generate 3.3V via IC112, and finally IC113 generates a 1.95V supply for the processor core. In addition IC107d provides a power-fail signal that ensures that data is saved at each power-off.

Regulation

The output current is sensed via shunt R143 and the signal amplified via IC116. This is fed into the A/D converter IC102 and also into IC115c where it is compared against the demand to regulate the current. Similarly IC115a and IC115d regulate the output voltage with the two loops having a diode 'OR' connection to give a clean crossover between constant voltage and constant power modes. Unregulated mode is detected separately on the Power board. IC107a and IC107b provide signals to the processor so that it knows what mode the power supply is in.

Demand Setting

The voltage and current demands, together with OVP limit and the pseudo-analogue outputs are generated by a digital to analogue converter IC105 together with analogue switch IC106 and a series of sample and hold circuits. For each of the 5 channels the setting consists of a both a setting of a DAC reference and a value setting. Consider the voltage demand as an example. First the processor sets the analogue switch IC104a directly across IC103 and sets IC106 to connect to IC108a. Writing a suitable value to the DAC sets the reference for the next conversion. The processor now opens the switch to the input of IC108a so that the setting is held. Next, switch

IC104 is switched so that R119 and R120 in circuit. This gives the correct reference for the demand to be set. Now the processor writes the correct demand to the DAC and once it has had time to settle, the output is switched via IC106 through to IC108b where the demand is held on C113. This whole process is repeated in a similar way for each of the 5 channels. Note that the voltage demand channel 'Volts Set' and the current demand 'Amps Set' have additional filtering to prevent large over/undershoots when the demand is changed.

Measurement

The system accurately measures the output voltage and current and also external demand signals for pseudo-analogue control. This is achieved via IC402, an analogue to digital converter. IC101a provides a clean, buffered reference. This chip communicates with the processor via an SPI bus.

OVP

IC107c provides over-voltage protection. It compares the OVP limit, set by IC108d, with the output voltage. When the output voltage becomes excessive it latches, pulling the voltage demand to zero via Q111 and Q112. The processor can reset the latch via Q113.

Remote Sense

RL100 selects between remote and local sensing controlled by the processor via Q109. Q106 and Q107 sense excessive drop down the sense cables, indicating a sense fault to the processor via Q105, if appropriate.

Logic in and Logic Out

The system has input and output logic signals which communicate with the processor via buffer transistors Q100 and Q101.

Keyboard

The keyboard processor IC2 acts as the system master initiating all communications within the unit; it is programmed in-circuit using the standard JTAG port accessed at PJ3. PJ9 and PJ10 provide the connections to the other boards in the system; Q2 and IC5 enable the processor to pull down the data line, allowing it to go high only if none of the processors in the system want to pull it low. The firmware operates a master-slave system to ensure there are no data clashes.

The board is supplied with 5V from the PFC board via PJ4. This is used to generate a local 3.3V supply (IC4) and 1.95V supply (IC3). IC7a, together with Q1 and associated components, provide a current source for the display LED backlight. IC7b and associated components provides a crude under-voltage detect to ensure the processor starts and shuts down cleanly. IC6 is a simple latch for the LEDS and the keyboard is scanned directly by the processor: this is a quiet scan that only scans when keys buttons are pressed or released not when the keys are left open or held down. The diodes D1 to D4 allow the processor to use some pins for two purposes (key-scan and LED).

The display is a 240x64 pixel LCD mounted directly on the keyboard PCB and connected via PJ6. The display contains its own voltage multiplier to generate the required bias levels; the switched capacitors and decoupling are provided directly on the pins of the display connector.

Interface Board

The interface board allows the unit to communicate externally via USB or RS232. IC5 is an ARM7 processor which is programmed in-circuit using the standard JTAG port accessed at PJ5.

IC3 and IC6 generate the required supply rails. PJ3 provides an RS232 connection; IC1 and IC2 provide the necessary level shifting and inversion to convert the UART's 5V 'mark' and 0V 'space' to RS232's –5V mark and +5V space. They also allow for data to pass through from one unit to another for TTi's Addressable RS232 Chain (ARC). USB is controlled directly by the processor; Q1 switches R22 to provide a soft connect/disconnect feature.

PJ3 provides a shared connection between the boards in the system; Q2 and IC4 allow the processor to pull down the data line (pin) allowing it to go high only if none of the processors in the system want to pull low. The firmware operates a master-slave system to ensure there are no data clashes.

Calibration Procedure

The QPX1200 calibration menu can be found under extra functions “#99”. The output calibrations are dependent on the measurement being in calibration so it is recommended that each of the calibrations be done in the order they appear on the menu.

Equipment Required

Voltmeter capable of reading up to 65 Volts with 1mV accuracy and up to 15V with 100μV accuracy, a Current measurement system capable of measuring 60 Amps with 10mA accuracy, and resistance less than 100mΩ (e.g. a 4-terminal shunt).

Procedure

01: Vout measurement calibration

Ensure that there is no load connected to the unit and connect the voltmeter directly across the front panel output terminals. Select option 1 from the Calibration menu (Vout measurement) and press OK. The unit now gives an output of about 1 Volt; measure it, enter the actual voltage (to the nearest mV) and press OK. After a few seconds the output changes to about 50 Volts; measure and enter this to the nearest mV, press OK. After a few seconds the display changes to the Calibration menu again; output voltage measurement is now calibrated.

02: Vout setting calibration

Ensure there is no load connected to the unit. Select option 2 from the Calibration menu (Vout setting) and press OK. The unit self-calibrates; during this time the output voltage will be switching between different levels. After a few seconds the display changes to the Calibration menu again; output voltage setting is now calibrated.

03: Iout measurement calibration

Connect the current measurement system directly across the front panel terminals. Select option 3 from the Calibration menu (Iout measurement) and press OK. The unit now gives an output of about 1 Amp; measure it accurately, enter the actual current to the nearest mA, and press OK. After a few seconds the output changes to about 50 Amps; measure and enter this to the nearest mA and press OK. After a few seconds the display changes to the Calibration menu; output current measurement is now calibrated.

04: Iout setting calibration

Connect the current measurement system directly across the front panel terminals or alternatively connect a direct short-circuit. Select option 4 from the Calibration menu (Iout setting). The unit self-calibrates; during this time the output current will be switching between different levels. After a few seconds the display changes to the Calibration menu; output current setting is now calibrated.

05: Vmon measurement calibration

On the rear panel terminals short ‘Vmonitor’ to ‘Vcontrol’. Ensure that there is no load connected to the unit and connect the voltmeter from ‘Vmonitor’ to ‘Common’. Select option 5 from the Calibration menu (Vmon measurement) and press OK. The unit now gives an output of about 1 Volt; measure the voltage at ‘Vmonitor’ and enter the output voltage this represents (e.g. 6 times the voltage measured for the 0V to 10V range) to the nearest mV and press OK. After a few seconds the output changes to about 50 Volts; measure and enter the voltage represented by the voltage at ‘Vmonitor’ to the nearest mV and press OK. After a few seconds the display changes to the Calibration menu; output voltage control is now calibrated.

06: Vmon setting calibration

On the rear panel terminals short ‘Vmonitor’ to ‘Vcontrol’. Ensure there is no load connected. Select option 6 from the calibration menu (Vmon setting) and press OK. The unit self-calibrates; during this time the output voltage will be switching between different levels. After a few seconds the display changes to the Calibration menu; output voltage monitor is now calibrated.

07: Imon measurement calibration

On the rear panel terminals short ‘Imonitor’ to ‘Icontrol’. Ensure that there is no load connected to the unit and connect the voltmeter from ‘Imonitor’ to ‘Common’. Select option 7 from the Calibration menu (Imon measurement) and press OK. The unit now gives an output of about 1 Amp; measure the voltage at ‘Imonitor’ and enter the output current this represents (e.g. 5 times the current measured for the 0V to 10V range) to the nearest mA and press OK. After a few seconds the output changes to about 50 Amps; measure and enter the current represented by the voltage at ‘Imonitor’ to the nearest mA and press OK. After a few seconds the display changes to the calibration menu output voltage control is now calibrated.

08: Imon setting calibration

On the rear panel terminals short ‘Imonitor’ to ‘Icontrol’. Connect the current measurement system directly across the front panel terminals or alternatively connect a direct short-circuit. Select option 8 from the calibration menu (Imon setting) and press OK. The unit self calibrates; during this time the output current will be switching between different levels. After a few seconds the display changes to the Calibration menu; output current monitor is now calibrated.

PCB ASSEMBLY - POWER - (44115-3060)

Part Number	Description	Position
20205-0800	STUD M6 x 20 HFHB M6-20-X	OUTPUT CONNECTION
20234-0023	SCREW M4 x 8 PNHDPZ ZPST	HEATSINKS
20234-0100	SCREW M3 x 6PNHDPZ C/W EXT SH/P	PCB SUPPORT SPACERS
20613-0007	SIL-PAD TO220 PLAIN	FOR TH1
20613-0026	SIL-PAD 900S 100MM X 25MM	FOR HEATSINKS
20661-0225	SPACER Hex M3 x 12 NPBR	PCB SUPPORT
20670-0135	CLIP GP02 FOR PCB MTG H/SINKS	
20670-0310	HEATSINK PCB MTG 38MM PLAIN	SK3
20670-0340	HEATSINK TO220 CLIPON 29DEG/W	SK4
20670-0364	CLIP MAX01H FOR TO220+MAX H/S	FOR TH1, TH3
20670-0365	CLIP MAX03H FOR TO247+MAX H/S	FOR Q2-6, Q8, Q28, Q29, D3, D6-7, D11
20670-0550	HEATSINK MAX505 90MM PLAIN	SK1
20670-0560	HEATSINK MAX505 210MM PLAIN	SK2
22040-0940	BEAD (DOUBLE) - FERRITE	FB1-7
22109-0130	TRANSFORMER GATE DRIVE	T3
22109-0280	TRANSFORMR CURRENT SENSE	CT1
22109-0370	TRANSFORMER HF POWER	T1
22109-0400	TRANSF GATE DRIVE QPX POSTREG	T4-5
22154-0160	CHOKE 1mH AXIAL 1.3 OHMS	L3-4
22154-0770	CHOKE - OUTPUT -QPX	L1
22154-0780	CHOKE - 3uH - ZVS	L2
22455-0040	TAB 4.8MAX 0.8MM STR PCB MTG	FAS1-2
22467-0130	TERMINAL BLOCK 2W R/A	TB1-6
22482-0020	BEAD, CERAMIC 11-54-3557-0	FOR R12-15
22573-0086	HEADER 16W 2x8 LATCHING	PJ4
22573-0210	HEADER 10 WAY STRAIGHT .156P	PJ5
22573-0224	HEADER 4 WAY STR F/LOCK .156P	PJ1 (FIT PIN 1 TO PIN 1)
22573-0247	HEADER 2 WAY STR .1P F/LOCK	PJ6-8
22575-0038	HEADER 6 WAY STR SIL	TP4, TP5
23185-0000	RES ZERO OHM	R155, R156
23202-0100	RES 10R0F W60 MF 50PPM	R37, R41, R52, R73
23202-0270	RES 27R0F W60 MF 50PPM	R45
23202-1100	RES 100RF W60 MF 50PPM	R2, R4-6, R49
23202-2330	RES 3K30F W60 MF 50PPM	R33-34
23202-5680	RES 6M80F W60 MF 50PPM	R27-28

PCB ASSEMBLY - POWER - (44115-3060) /continued...

Part Number	Description	Position
23210-0330	RES 33R0J 2W MF 250PPM	R26
23210-1100	RES 100RJ 2W MF 250PPM	R140
23210-1220	RES 220RJ 2W MF 250PPM	R51, R141
23210-2470	RES 4K70J 2W MF 250PPM	R127
23210-3470	RES 47K0J 2W MF 250PPM	R131-132, R149-150
23215-2100	RES 1K00B W25 MF 15PPM	R72, R85
23222-0022	RES 2R20J W33 MF FUSIBLE NRF25	R88
23222-0220	RES 22R0J W33 MF FUSIBLE NRF25	R56, R138-139
23222-0220	RES 22R0J W33 MF FUSIBLE NRF25	R50
23222-1220	RES 220RJ W33 MF FUSIBLE NFR25	R10, R17
23274-0042	RES 47RJ 2W5 WW	R7, R11, R18
23274-0043	RES 0R015J 2W5 WW	R12-15
23274-0320	RES 220RJ 4W WW	R55
23275-0010	RES 47R0J 3W MO	R8
23385-2100	RES PS/H 1K0 CF 6MM	VR3
23385-3100	RES PS/H 10K CF 6MM	VR1-2, VR5
23385-3470	RES PS/H 47K CF 6MM	VR4
23388-0010	THERMISTOR PTC TAG 90 DEG	TH1 ,TH3
23424-0469	CAP 220PK 1KV CER P5	C16
23424-0471	CAP 4N7K 1KV CER P7.5/P10	C4, C6, C12
23424-0472	CAP 2N2K 1KV CER P5/P7.5	C13-14
23428-0470	CAP 47PG 100V CER NPO P2.5	C59, C66
23557-0506	CAP 10U 63V ELEC P2	C25
23557-0667	CAP 220U 25V ELEC RE2 P3.5	C40
23557-0673	CAP 22U 35V ELEC RE2 P2	C10, C15, C20, C43-44, C53, C87
23557-0820	CAP 10U 50V ELEC LOW ESR P2	C17
23557-0827	CAP 470U 100V LOW ESR P7.5	C5, C7-8, C11 ,C18
23620-0236	CAP 1N0K 100V P/E P5	C27
23620-0252	CAP 2N2K 63V P/E P5	C37-38, C58, C64, C76-77
23620-0264	CAP 100NK400VP/E 368 SER P15	C80
23620-0267	CAP 100NK 100V P/E P5	C21, C26, C91-92
23620-0268	CAP 220NK400VP/E 468 SER P15	C22, C102
23684-0021	CAP 2U2K 400V P/P P27.5	C1-3
23685-0013	CAP 330NK 160V/250V P/P P15	C35
25021-0910	DIO BAV21	D1-2, D13, D15, D19, D29, D31, D35, D38, D55

PCB ASSEMBLY - POWER - (44115-3060) /continued...

Part Number	Description	Position
23210-0330	RES 33R0J 2W MF 250PPM	R26
25031-0100	DIO BAX12A	D16-17, D22-23
25031-0150	DIO UF4006	D47
25031-0250	DIO STTH6003CW	D3, D6-7, D11
25130-0207	DIO ZEN 15V W4	D25-26, D36
25130-0231	DIO ZEN 8V2 W4	D37, D56
25130-0915	DIO ZEN 75V W4	D5
25349-3500	TRAN PNP MJE350	Q37
25384-9001	TRAN PNP ZTX751	Q15, Q18
25388-0211	TRAN NPN ZTX651	Q13, Q17
25601-0490	TRAN MOSFET N CHAN 50V/60V	Q38
25601-0710	TRAN MOSFET NCHAN HUF75652G3	Q3-6
25601-0750	TRAN MOSFET N CHAN STW45NM50	Q28-29
25601-0800	TRAN MOSFET NCHAN IRFP90N20DPF	Q2, Q8
27001-0060	OPTO-COUPLER SFH615A-3	IC1, IC17-18
27160-0013	IC V/REG 7815	IC9

PCB ASSEMBLY SM POWER (44115-3061)

Part Number	Description	Position
22469-1000	TEST POINT SMT	TP6,TP8-9,TP11-15
23105-0000	RES SM0805 ZERO OHM	R97
23105-0010	RES SM0805 1R00F W1	R100
23105-0022	RES SM0805 2R20F W1	R120-121
23105-0033	RES SM0805 3R30F W1	R3, R24
23105-0100	RES SM0805 10R0F W1	R29, R144-145
23105-0220	RES SM0805 22R0F W1	R128, R130, R142-143
23105-0240	RES SM0805 24R0F W1	R158
23105-0750	RES SM0805 75R0F W1	R157
23105-1100	RES SM0805 100RF W1	R40, R43
23105-1470	RES SM0805 470RF W1	R25, R65, R76, R102, R125, R153-154
23105-2100	RES SM0805 1K00F W1	R20, R30-32, R39, R42, R64, R69-70, R74-75, R80, R83, R90, R92, R117-118
23105-2180	RES SM0805 1K80F W1	R16, R99
23105-2220	RES SM0805 2K20F W1	R63, R107
23105-2300	RES SM0805 3K00F W1	R36
23105-2330	RES SM0805 3K30F W1	R44, R84, R86, R98, R147
23105-2470	RES SM0805 4K70F W1	R67-68, R77, R79, R81, R129

PCB ASSEMBLY SM POWER (44115-3061) /continued...

Part Number	Description	Position
23105-2510	RES SM0805 5K10F W1	R66, R78
23105-3100	RES SM0805 10K0F W1	R9, R22, R53, R58, R61, R71, R82, R87, R89, R94, R96, R104-106, R109, R112-115, R124, R126, R146
23105-3200	RES SM0805 20K0F W1	R137
23105-3220	RES SM0805 22K0F W1	R35, R46-47, R95, R108, R122
23105-3330	RES SM0805 33K0F W1	R21
23105-3390	RES SM0805 39K0F W1	R91
23105-3470	RES SM0805 47K0F W1	R57, R60, R123
23105-3620	RES SM0805 62K0F W1	R119
23105-4100	RES SM0805 100KF W1	R62, R110
23105-4220	RES SM0805 220KF W1	R19, R48, R54
23105-4470	RES SM0805 470KF W1	R111, R116
23105-4750	RES SM0805 750KF W1	R38, R101
23105-5100	RES SM0805 1M00F W1	R93
23461-0015	CAP SM0805 10NK 50V CER X7R	C47-48, C65, C79
23461-0020	CAP SM0805 100N50V CER Y5V	C19, C34
23461-0030	CAP SM0805 220NK 16V CER X7R	C94-95
23461-0050	CAP SM0805 22NJ 50V CER X7R	C85
23461-0300	CAP SM0805 100NK 25V CER X7R	C24, C28-33, C36, C42, C45, C49-52, C54-55, C57, C61-63, C67-70, C72, C75, C88-90, C96
23559-5220	CAP SM 22U 35V AL ELEC	C86,C93
23595-0100	CAP SM-B 4U7M 16V TANT	C39
25021-0050	DIO SM BAV99 SWITCHING	D9, D14, D18, D20, D28, D30, D32, D39-44, D46, D50-52
25061-0300	LED SM - RED 3.2 X 2.8MM	LED1-2
25132-0200	DIO SM ZEN 6V2 W35	D27
25132-0270	DIO SM ZEN 7V5 W35	D45
25132-0310	DIO SM ZEN 5V6 W35	D4, D8, D12, D24, D49
25132-0320	DIO SM ZEN 3V3 W35	D10
25334-1010	TRAN SM PNP MMBT2907A	Q20, Q24
25340-1000	TRAN SM PNP BC859C	Q9, Q16, Q31, Q34-35
25377-1000	TRAN SM NPN BC849C	Q11-12, Q14, Q21, Q25, Q30, Q32, Q36
25381-1000	TRAN SM NPN SMBT3904	Q22-23, Q26-27
27106-1110	IC SM LM358M DUAL OP AMP	IC5, IC8, IC14-15
27106-1210	IC SM LMC662CM	IC7

PCB ASSEMBLY SM POWER (44115-3061) /continued...

Part Number	Description	Position
27151-1030	IC SM AD633	IC6
27227-0130	IC SM 4013	IC3
27227-0690	IC SM 4069	IC2
27227-0810	IC SM 4081	IC10
27253-0140	IC SM MIC4428	IC11, IC13
35555-4690	PCB - POWER	

PCB ASSEMBLY CONTROL (44115-3180)

Part Number	Description	Position
10300-0324	PAD P/E S/AD 6 X 3MM	FOR XTAL
20030-0263	WASHER M3 ZPST	FOR R143
20037-0401	SOLDER TAG PLAIN - M4	FOR R143
20038-9501	WASHER M3 SPRING	FOR R143
20210-0101	NUT M3 ZPST	FOR R143
20210-0110	NUT M4 BARB	FOR R143
20234-0023	SCREW M4 X 8 PNHDPZ ZPST	FOR R143
20234-0024	SCREW M3 X 16 PNHDPZ ZPST	FOR R143
20613-0016	SIL-PAD RECTIFIER	FOR R143
20661-0873	SPACER TOWER 4.8OD X 6L	FOR LED100
20670-0580	HEATSINK TO220 AAVID 7025B	FOR R143
22240-0070	RELAY TYPE 47 (12VDC)	RL100
22467-0120	TERMINAL BLOCK 2W LIGHT GREY	SK100
22573-0048	HEADER 3WAY STR SIL STD/GOLD	TP100
22573-0086	HEADER 16W 2x8 LATCHING	PJ101
22573-0210	HEADER 10 WAY STRAIGHT .156P	PJ100
22573-0248	HEADER 3 WAY STR .1P F/LOCK	PJ105
22575-0065	HEADER 20 WAY 2X10 STR SKELN	PJ103
23202-2100	RES 1K00F W60 MF 50PPM	R136, R138
23215-2383	RES 3K83B W25 MF 15PPM	R155, R219
23215-3909	RES 90K9B W25 MF 15PPM	R156, R160
23215-4680	RES 680KB W25 MF 15PPM	R103-104
23296-0060	RES 0R002 4 TERM PBV	R143
23557-0731	CAP 100U 100V ELEC LOW ESR	C120-121
23557-0841	CAP 47U 35V ELEC P2	C2
23620-0249	CAP 330NK 63V P/E P5	C112-117
23620-0268	CAP 220NK400VP/E 468 SER P15	C118-119
23662-0207	CAP 470PK 100V P/C P5	C30

PCB ASSEMBLY CONTROL (44115-3180) /continued...

Part Number	Description	Position
25061-0201	LED - T1 ROUND(3MM) RED	LED100
25117-0020	DIO 1N5401	D110
27001-0050	OPTO-COUPLER 6N136	IC109-110
27160-0009	IC V/REG 7805	IC117
27161-0060	IC V/REF LT1009 2.50V	IC100
28500-0800	XTAL - 4.9152MHZ-MICROPROCSR	X101
28502-0020	RESONATOR CERAMIC 12MHZ	X100
35358-0600	BUS BAR - CONTROL	

PCB ASSEMBLY SM CNTL (44115-3181)

Part Number	Description	Position
23105-0000	RES SM0805 ZERO OHM	R121-122, R185
23105-0220	RES SM0805 22R0F W1	R5
23105-0470	RES SM0805 47R0F W1	R112
23105-0560	RES SM0805 56R0F W1	R225
23105-1100	RES SM0805 100RF W1	R193
23105-1220	RES SM0805 220RF W1	R40-41, R220
23105-1270	RES SM0805 270RF W1	R105, R108, R173-174
23105-1330	RES SM0805 330RF W1	R126-131
23105-1430	RES SM0805 430RF W1	R144-145
23105-1560	RES SM0805 560RF W1	R7, R208
23105-2100	RES SM0805 1K00F W1	R123, R125, R137, R139, R150, R152, R166, R175, R187-190, R196, R202, R207
23105-2120	RES SM0805 1K20F W1	R6
23105-2200	RES SM0805 2K00F W1	R117-118
23105-2220	RES SM0805 2K20F W1	R124, R151, R204
23105-2270	RES SM0805 2K70F W1	R133
23105-2330	RES SM0805 3K30F W1	R111
23105-2360	RES SM0805 3K60F W1	R100
23105-2390	RES SM0805 3K90F W1	R135
23105-2470	RES SM0805 4K70F W1	R154, R168
23105-2680	RES SM0805 6K80F W1	R113
23105-2820	RES SM0805 8K20F W1	R114, R132, R147-148
23105-3100	RES SM0805 10K0F W1	R1-4, R106-107, R109-110, R142, R149, R159, R162, R169-172, R176-183, R198-201, R203, R205, R215, R222
23105-3150	RES SM0805 15K0F W1	R134, R209-210, R211, R218

PCB ASSEMBLY SM CNTL (44115-3181) /continued...

Part Number	Description	Position
23105-3200	RES SM0805 20K0F W1	R119
23105-3220	RES SM0805 22K0F W1	R163, R165
23105-3270	RES SM0805 27K0F W1	R217
23105-3470	RES SM0805 47K0F W1	R140-141, R191, R206, R212
23105-3680	RES SM0805 68K0F W1	R194, R197
23105-4100	RES SM0805 100KF W1	R120, R153, R164, R167, R192, R221
23105-4330	RES SM0805 330KF W1	R224
23105-4470	RES SM0805 470KF W1	R158
23105-4560	RES SM0805 560KF W1	R213-214, R223
23105-6100	RES SM0805 10M0F W1	R146, R195
23107-3270	RES SM0805 27K0B W1 25PPM	R101-102
23407-0100	CAP SM0805 10P CER NPO	C107-108
23407-0220	CAP SM0805 22P CER NPO	C146-147
23407-0470	CAP SM0805 47P CER NPO	C109, C123, C130
23411-1104	CAP SM1206 100NK 100V CER X7R	C3-7
23461-0015	CAP SM0805 10NK 50V CER X7R	C31, C165
23461-0020	CAP SM0805 100N50V CER Y5V	C1, C100-102, C104-106, C111, C132, C134, C137, C139, C141-143, C145, C148, C150-C162, C166, C176
23461-0030	CAP SM0805 220NK 16V CER X7R	C28, C168-169
23461-0040	CAP SM0805 1N0K 50V CER X7R	C164
23461-0070	CAP SM0805 4N7J 50V CER X7R	C124
23461-0300	CAP SM0805 100NK 25V CER X7R	C170, C172
23559-4101	CAP SM 100U 25V AL ELEC	C133, C135-136, C138, C140, C144, C149, C167
23559-5100	CAP SM 10U 35V AL ELEC	C103, C110
23595-0010	CAP SM-A 1U0M 16V TANT	C163
23662-0108	CAP 2N2K 100V P/C P5	C30
25021-0050	DIO SM BAV99 SWITCHING	D103, D116-117
25021-0070	DIO SM BAS116	D105
25021-1010	DIO SM BAS21	D100-102, D106-107, D111, D113-114
25031-1030	DIO SM ZHCS500	D1-2
25132-0100	DIO ZEN 3V9 W5	D104
25132-0320	DIO SM ZEN 3V3 W35	D3, D112
25340-1000	TRAN SM PNP BC859C	Q100-101, Q103, Q105
25377-1000	TRAN SM NPN BC849C	Q102, Q104, Q109-111, Q114-115
25391-0010	TRAN SM NPN BF820	Q106-107

PCB ASSEMBLY SM CNTL (44115-3181) /continued...

Part Number	Description	Position
25603-0220	TRAN SM FET N FDV303N 25V	Q112-113
27103-1010	IC SM LM339A QUAD	IC107
27106-0644	IC SM TL074CD BI-FET OP-AMP	IC103, IC108
27106-1110	IC SM LM358M DUAL OP AMP	IC114
27106-1160	IC SM LM324M OP AMP	IC115
27106-1350	IC SM OPA277 PREC AMP	TIC101, IC116
27153-1160	IC SM ADS1241 8x24ADC	IC102
27153-1190	IC SM DAC8551	IC105
27160-1010	IC SM V/REG LM1117 ADJ	IC113
27160-1030	IC SM V/REG LM1117-3V3	IC112
27227-0510	IC SM 4051	IC106
27236-0530	IC SM 74HC4053	IC104
27250-2190	IC SM MCU LPC2102	IC111
35555-4960	PCB – CONTROL	

PCB ASSEMBLY – PFC (44115-3100)

Part Number	Description	Position
20234-0023	SCREW M4 X 8 PNHDPZ ZPST	HEATSINKS
20234-0100	SCREW M3x6PNHDPZ C/W EXT SH/P	PCB SUPPORT SPACERS
20613-0007	SIL-PAD TO220 PLAIN	FOR TH2
20613-0026	SIL-PAD 900S 100MM X 25MM	FOR HEATSINKS
20661-0225	SPACER Hex M3 x 12 NPBR	PCB SUPPORT
20670-0340	HEATSINK TO220 CLIPON 29DEG/W	FOR IC7 & IC5
20670-0364	CLIP MAX01H FOR TO220+MAX H/S	FOR D5, D6, D33, TH2
20670-0365	CLIP MAX03H FOR TO247+MAX H/S	FOR D1-4, Q1-6
20670-0550	HEATSINK MAX505 90MM PLAIN	SK1
20670-0560	HEATSINK MAX505 210MM PLAIN	SK2
22040-0901	BEAD FERRITE FX1115	FIT TO PIN 1 OF FET Q1-6
22040-0920	BEAD FERRITE - LEADED - B/R	FB4-9
22040-0940	BEAD (DOUBLE) – FERRITE	FB1-3
22109-0350	TRANSFORMER AUX 5V	T1
22109-0380	TRANSFORMER AUX PRIMARY	T9
22154-0210	CHOKE - 2uH	L9-11
22154-0240	INDUCTOR BOOST	L5-7
22154-0740	CHOKE 17.5uH/12A	L4, L8
22154-0790	CHOKE 2mH/15A COMMON MODE	L1-3
22240-0210	RELAY SPST (24V) G8P	RL1

PCB ASSEMBLY – PFC (44115-3100) /continued...

Part Number	Description	Position
22312-0250	FUSE CLIP 0.25in. PCB MTG	FS1
22315-0255	FUSE 15A HRC 1.25 X 0.25	FOR FS1
22455-0030	TAB 0.25in. STR PCB MTG	W1-5
22455-0040	TAB 4.8MAX 0.8MM STR PCB MTG	FAS5-6
22482-0020	BEAD, CERAMIC 11-54-3557-0	FOR R2, R52
22520-0190	AC RECEP 10/15 AMP R/A SOLDER UL	PJ3
22573-0070	HEADER 4WAY STR SIL STD	PJ4
22573-0222	HEADER 2 WAY STR F/LOCK .156P	PJ2
22573-0224	HEADER 4 WAY STR F/LOCK .156P	PJ1
23185-0000	RES ZERO OHM	R92
23207-4100	RES 100KJ 1W MF 250PPM	R28, R55
23207-4220	RES 220KJ 1W MF 250PPM	R25-26
23210-4150	RES 150KJ 2W MF 250PPM	R1
23222-0470	RES 47R0J W33 MF FUSIBLE NFR25	R89
23222-1220	RES 220RJ W33 MF FUSIBLE NFR25	R86
23271-0019	RES 0R01J 2W MR	R52
23274-0220	RES 100RJ 7W WW (STAND-OFF)	R2
23274-0250	RES 1K0J 4W WW	R6, R9, R23
23275-0010	RES 47R0J 3W MO	R4, R12-13, R15-16, R18-19, R21-22
23385-3100	RES PS/H 10K CF 6MM	VR1
23386-0010	VARISTOR V275LA20A	VD1
23388-0010	THERMISTOR PTC TAG 90 DEG	TH2
23424-0459	CAP 4N7 250V AC CER Y	C5-6, C11-14
23424-0469	CAP 220PK 1KV CER P5	C17, C22-24, C63-64
23424-0472	CAP 2N2K 1KV CER P5/P7.5	C47, C54
23424-0476	CAP 4N7M 250V CER Y1/X1 P10	C69
23557-0506	CAP 10U 63V ELEC P2	C66
23557-0615	CAP 470U 16V RE3 P3.5	C59
23557-0665	CAP 2U2 50V ELEC RE2 P2	C21
23557-0666	CAP 47U 63V ELEC RE2 P3.5	C49
23557-0673	CAP 22U 35V ELEC RE2 P2	C44, C67
23557-0831	CAP 10U 400V ELEC P5	C81
23557-0841	CAP 47U 35V ELEC P2	C34
23557-0950	CAP 470U 400V ELEC S/I P10	C19-20
23620-0236	CAP 1N0K 100V P/E P5	C42-43
23620-0264	CAP 100NK400VP/E 368 SER P15	C37, C46

PCB ASSEMBLY – PFC (44115-3100) /continued...

Part Number	Description	Position
23620-0267	CAP 100NK 100V P/E P5	C35, C35B
23620-0268	CAP 220NK400VP/E 468 SER P15	C70
23684-0016	CAP 220NM 250VAC X2 P22.5 UL	C68
23684-0023	CAP 2U2M 275VAC X2 P/P UL	C1, C4, C7, C10, C15-16
23685-0013	CAP 330NK 160V/250V P/P P15	C18, C61-62
25031-0150	DIO UF4006	D20
25031-0200	DIO BYC10-600	D5-8, D19, D33
25115-0910	DIO 1N4007 B/R	D9
25117-0040	DIO 40EPS08	D1-4
25601-0740	TRAN MOSFT NCHAN IRFPS37N50A	Q1-6
27001-0060	OPTO-COUPLER SFH615A-3	IC10, IC13, IC15
27156-0030	IC TOP244Y	IC5
27160-0013	IC V/REG 7815	IC7
27160-0032	IC V/REG 7818	IC6
31547-0750	SCREEN PFC CHOKE	FOR L5-L7

PCB ASSEMBLY SM – PFC (44115-3101)

Part Number	Description	Position
22469-1000	TEST POINT SMT	TP1
23105-0000	RES SM0805 ZERO OHM	LK2
23105-0068	RES SM0805 6R80F W1	R94
23105-0100	RES SM0805 10R0F W1	R90
23105-0330	RES SM0805 33R0F W1	R5, R8, R11, R14, R17, R20
23105-0470	RES SM0805 47R0F W1	R27
23105-1220	RES SM0805 220RF W1	R3, R57, R95-96
23105-2100	RES SM0805 1K00F W1	R47, R56, R78
23105-2220	RES SM0805 2K20F W1	R71, R80, R82
23105-2330	RES SM0805 3K30F W1	R24, R43, R48, R50, R79, R91
23105-2470	RES SM0805 4K70F W1	R54, R58, R62-63, R74, R76-77
23105-3100	RES SM0805 10K0F W1	R31-33, R49, R64-65, R68, R72, R81, R85
23105-3220	RES SM0805 22K0F W1	R46, R75
23105-3270	RES SM0805 27K0F W1	R93
23105-3330	RES SM0805 33K0F W1	R37
23105-3360	RES SM0805 36K0F W1	R51
23105-3470	RES SM0805 47K0F W1	R61
23105-4100	RES SM0805 100KF W1	R99-104

PCB ASSEMBLY SM – PFC (44115-3101) /continued...

Part Number	Description	Position
23105-4180	RES SM0805 180KF W1	R59-60, R59B, R60B
23105-4220	RES SM0805 220KF W1	R40-42, R70, R41B, R42B
23105-4330	RES SM0805 330KF W1	R34-35, R38-39, R34B, R35B, R38B, R39B
23105-4360	RES SM0805 360KF W1	R36
23105-4430	RES SM0805 430KF W1	R45, R44B, R45B
23105-4470	RES SM0805 470KF W1	R29, R30, R29B, R30B
23105-4510	RES SM0805 510KF W1	R44
23105-4750	RES SM0805 750KF W1	R10
23105-5100	RES SM0805 1M00F W1	R66-67, R69, R73
23406-2474	CAP SM0805 470NK 16V CER X7R	C55-56
23407-0471	CAP SM0805 470P CER NPO	C41
23411-0104	CAP SM1206 100NK 50V CER X7R	C36, C36B
23461-0015	CAP SM0805 10NK 50V CER X7R	C65
23461-0200	CAP SM0805 2N2J 50V CER X7R	C40
23461-0300	CAP SM0805 100NK 25V CER X7R	C25-33, C38-39, C45, C48, C50-53, C57-58, C60, C71-79
23559-3470	CAP SM 47U 16V AL ELEC	C82
23559-5100	CAP SM 10U 35V AL ELEC	C80
25021-0050	DIO SM BAV99 SWITCHING	D11, D18, D24-32, D34
25115-1010	DIO SM US1J 1A 600V 75ns	D10, D21
25115-1010	DIO SM US1J 1A 600V 75ns	D36, D37
25132-0230	DIO SM ZEN 5V1 W35	D23
25132-0310	DIO SM ZEN 5V6 W35	D35
25132-0330	DIO SM ZEN 24V W35	D22
25132-0340	DIO SM ZEN 12V W35	D38
25377-1000	TRAN SM NPN BC849C	Q8-11, Q13
27106-1110	IC SM LM358M DUAL OP AMP	IC12
27106-1160	IC SM LM324M OP AMP	IC8
27156-0180	IC SM TNY267G	IC9
27160-1070	IC SM TL431	IC11
27168-1030	IC SM L4981AD	IC4
27253-0150	IC SM MIC4427	IC1-3
35555-4600	PCB - PFC	

PCB ASSEMBLY KEYBOARD (44115-3110)

Part Number	Description	Position
20661-0282	SPACER Rnd 3.7 ID x 3.2 L Nyl	LCD FIXING
20661-0872	SPACER TOWER RND 4.8ODx8L	FOR LED1-5
22224-0020	ENCODER ROT 24 POSITION	SW1
22226-0101	KEYSWITCH - ALPS SKHHBW	K1-20
22573-0048	HEADER 3WAY STR SIL STD/GOLD	TP1-3
22573-0222	HEADER 2 WAY STR F/LOCK .156P	PJ4
22573-0247	HEADER 2 WAY STR .1P F/LOCK	PJ7
22573-0248	HEADER 3 WAY STR .1P F/LOCK	PJ9-10
22575-0065	HEADER 20 WAY 2X10 STR SKELN	PJ3
22575-0550	SKT 22W 1.0 FPC VERT	PJ6
23377-4100	RES PS/H 100K CF 10MM	VR1
25061-0201	LED - T1 ROUND(3mm) RED	LED1-5
26100-0240	LCD 240 X 64 GRAPHICS BACKLIT	LCD1
26100-0241	HOLDER FOR 26100-0240	
28151-0010	BUZZER - 41.T70P015H	BUZZ1
28502-0020	RESONATOR CERAMIC 12MHZ	X1

PCB ASSEMBLY SM KEYBOARD (44115-3111)

Part Number	Description	Position
23105-0000	RES SM0805 ZERO OHM	R4, R19, R21
23105-0047	RES SM0805 4R70F W1	R44
23105-0100	RES SM0805 10R0F W1	R32
23105-0560	RES SM0805 56R0F W1	R40
23105-1100	RES SM0805 100RF W1	R23
23105-1150	RES SM0805 150RF W1	R50-54
23105-2100	RES SM0805 1K00F W1	R1, R5-6, R9, R17, R22, R43, R45
23105-2220	RES SM0805 2K20F W1	R55
23105-3100	RES SM0805 10K0F W1	R24-31, R33-39, R41-42
23105-3150	RES SM0805 15K0F W1	R7
23105-3220	RES SM0805 22K0F W1	R2, R46
23105-3470	RES SM0805 47K0F W1	R10
23105-4100	RES SM0805 100KF W1	R8, R11-12
23105-4300	RES SM0805 300KF W1	R15
23105-4470	RES SM0805 470KF W1	R14
23105-5100	RES SM0805 1M00F W1	R13
23407-0220	CAP SM0805 22P CER NPO	C13-14

PCB ASSEMBLY SM KEYBOARD (44115-3111) /continued...

Part Number	Description	Position
23411-0475	CAP SM1206 4U7K 16V CER X7R	C1-3, C11-12
23461-0020	CAP SM0805 100NZ 50V CER Y5V	C16-17, C20-25
23461-0334	CAP SM0805 330NK 25V CER X7R	C6-10
23559-2221	CAP SM 220U 10V AL ELEC	C18-19
23559-4101	CAP SM 100U 25V AL ELEC	C4, C26-27
23595-0010	CAP SM-A 1U0M 16V TANT	C5, C15
25021-1010	DIO SM BAS21	D5
25031-1030	DIO SM ZHCS500	D1-4
25377-1000	TRAN SM NPN BC849C	Q2
25381-1020	TRAN SM NPN FZT651 60V 3A	Q1
27106-1110	IC SM LM358M DUAL OP AMP	IC7
27160-1010	IC SM V/REG LM1117 ADJ	IC3
27160-1030	IC SM V/REG LM1117-3V3	IC4
27161-2030	IC SM V/REF ZRC250 2.5V 2%	IC1
27239-0140	IC SM 74HC14	IC5
27239-5740	IC SM 74HC574	IC6
27250-2230	IC SM MCU LPC2103	IC2
35555-4760	PCB – KEYBOARD	

PCB ASSEMBLY R/TERMINAL (44115-3190)

Part Number	Description	Position
23557-0731	CAP 100U 100V ELEC LOW ESR	C1
23620-0267	CAP 100NK 100V P/E P5	C2
23620-0268	CAP 220NK400VP/E 468 SER P15	C3
35555-4980	PCB REAR TERMINAL	

PCB ASSEMBLY INTERFACE (44115-3150)

Part Number	Description	Position
22573-0248	HEADER 3 WAY STR .1P F/LOCK	PJ3
22574-0450	SKT 9W R/A D-TYPE (CLIP IN)	PJ2
22574-0495	SKT - USB TYPE B - PCB MTG	PJ1
22575-0065	HEADER 20 WAY 2X10 STR SKELN	PJ4-5
35358-0580	EARTHING SPRING USB	SP1

PCB ASSEMBLY SM INTRFACE (44115-3151)

Part Number	Description	Position
23105-0330	RES SM0805 33R0F W1	R3-4
23105-2100	RES SM0805 1K00F W1	R15, R19, R21
23105-2150	RES SM0805 1K50F W1	R22
23105-2220	RES SM0805 2K20F W1	R20
23105-3100	RES SM0805 10K0F W1	R1, R5-7, R10-14, R16-18, R25
23105-3470	RES SM0805 47K0F W1	R8-9
23105-4100	RES SM0805 100KF W1	R2, R23
23407-0180	CAP SM0805 18P CER NPO	C3, C11
23461-0020	CAP SM0805 100NZ 50V CER Y5V	C2, C9-10, C14
23461-0500	CAP SM0805 4U7 6V3 CER X5R	C4-6, C15
23559-2221	CAP SM 220U 10V AL ELEC	C12-13
23595-0010	CAP SM-A 1U0M 16V TANT	C1
25021-1010	DIO SM BAS21	D1
25061-0304	LED SM0805 RED	LED1
25377-1000	TRAN SM NPN BC849C	Q2
27160-1030	IC SM V/REG LM1117-3V3	IC3
27162-1060	IC SM TPS60401	IC6
27239-0140	IC SM 74HC14	IC4
27250-2210	IC SM MCU LPC2148	IC5
27253-0050	IC SM 14C88	IC2
27253-0060	IC SM 14C89	IC1
23407-0220	CAP SM0805 22P CER NPO	C7-8
25340-1000	TRAN SM PNP BC859C	Q1
23411-0475	CAP SM1206 4U7K 16V CER X7R	C16
23105-0000	RES SM0805 ZERO OHM	R24
28500-2040	XTAL SM 12MHZ 30/50PPM 16PF	XTL1
35555-4880	PCB - INTERFACE	

MECHANICAL PARTS

Part Number	Description	Position
10232-0306	SLEEVE 50 X 25MML BLACK	FOR POWER OUTPUT WIRES
10232-0360	TUBING PVC CLEAR 9.5ID	
10233-0106	TUBING H/S 9.5MM BORE CLEAR	
10366-0610	TAPE ALUMINIUM FOIL	
20500-0010	FAN GUARD 80MM	
20620-0010	CLIP - ENCODER KNOB	
20662-0570	FOOT SELF ADHESIVE GREY	FRONT FEET

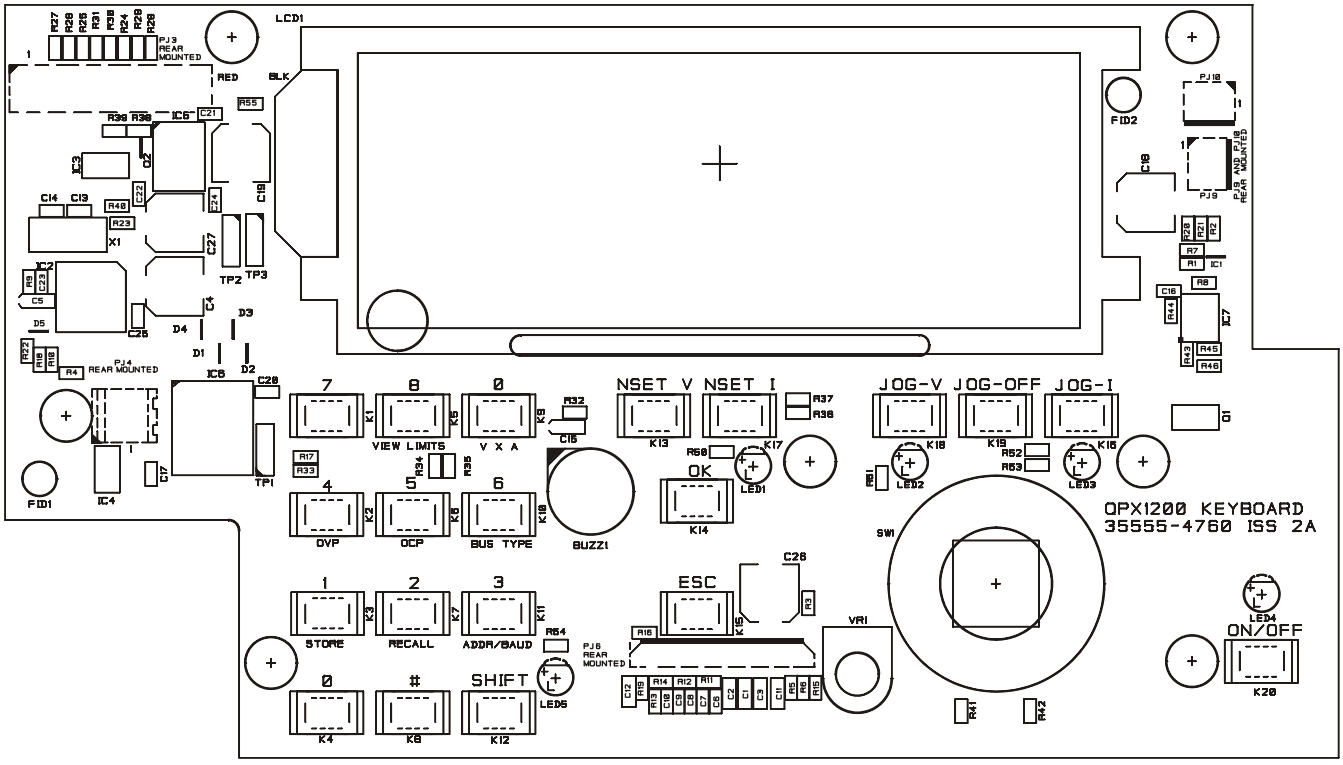
MECHANICAL PARTS /continued...

Part Number	Description	Position
20662-9101	INSTRUMENT FOOT	BACK FEET
22040-0030	FERRITE SLEEVE APPX 8/16/14L	SAFETY EARTH PFC TO POWER AUX MAINS TO FRONT PANEL (2) PFC TO KEYBOARD POWER TO CONTROL AUX
22040-0090	FERRITE SLEEVE 31x19IDx16L	POWER TO FRONT TERMINALS FRONT TO REAR TERMINALS
22219-0140	SWITCH ROCKER DPDT 16A 250V	
22454-0060	RECEPT RED FEMALE 4.8x0.8MM	POWER TO PFC WIRES
22491-0270	MAINS LD 2MST IEC SKT/EURO PL	
22491-0280	MAINS LD 2M ST IEC/UK PLUG 13A	
22571-0741	PIN ANTI-ROTATION (TP/44&244L)	
22571-1030	TERMINAL TP60 BLACK/BLACK 25MM	F/PANEL, R/PANEL
22571-1040	TERMINAL TP60 RED/BLACK 25MM	F/PANEL, R/PANEL
22571-1100	TERMINAL PSU SAFTY GREY/GREY	F/PANEL
22575-0077	SKT 2 WAY IDT .1P	FOR INTERNAL FAN
22575-0078	SKT 3 WAY IDT .1P	PJ5 CNTL TO PJ9 KEYBOARD PJ10 KEYBOARD TO I/F
22575-0202	SKT 2W .156 20AWG Yellow IDT	PJ4 ON KEYBOARD
22575-0204	SKT 4W .156 20AWG Yellow IDT	PFC TO POWER
22575-0210	SKT 10W.156 20AWG Yellow IDT	PJ5 POWER, PJ10 CNTL
28522-0030	FAN 80MM 24VDC 3000RPM	REAR PANEL (2), INTERNAL.
31512-1000	BRACKET WIRE SUPPORT	
31512-1020	BRACKET FAN SUPPORT	FOR INTERNAL FAN
31711-0190	BEZEL	
33143-0290	FOOT - TILT - HOUSING	
33143-0300	FOOT - TILT - SUPPORT	
33331-8850	FRONT PANEL	
33331-8860	REAR PANEL	
33331-8870	OVERLAY FRONT PANEL	
33537-1130	CASE LOWER	
33537-1140	CASE UPPER	
37113-2090	KEYCAP 8 x 4.5MM LIGHT GREY F/R	
37151-0430	KNOB ENCODER LIGHT GREY F/R	
43171-2600	CONN ASSEMBLY 16WPWR/CNTL	
48511-1030	INSTRUCTION MANUAL	
48511-1040CD	CD INSTRUCTION/DRIVERS	

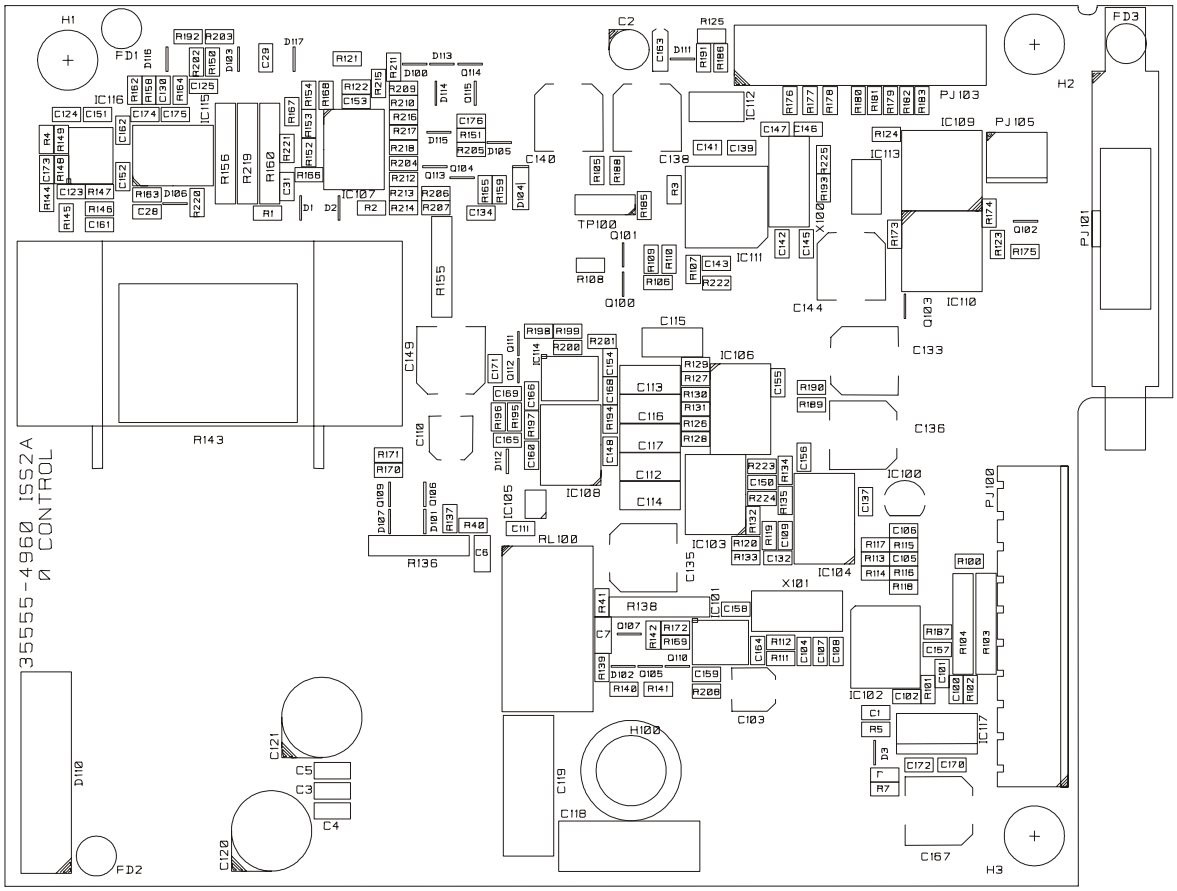
FIXINGS & FASTNERS

Part Number	Description	Position
20010-0254	RIVET SNAP-LOCK 4.1D X 5.5T	INTERNAL FAN FIXING
20010-0255	RIVET SNAP-LOCK 4.1Dx7.5T	FAN MOUNTING REAR PANEL
20010-0257	RIVET SNAPLOCK 3.6Dx2.2-3.1T	R.PANEL/CHASSIS
20030-0271	WASHER M4x12x1 ZPST	EARTH TERMINAL, EARTH
20037-0301	WASHER M3 SHK/PROOF I/T ZPST	CHASSIS/FRONT PANEL
20037-0304	WASHER M4 SHK/PROOF I/T ZPST	FRONT FEET REAR SAFETY EARTH REAR TERMINAL PCB FIXING
20037-0305	WASHER 5/16in.SHK/PRF I/T ZPST	FOR FRONT PANEL EARTH
20038-9502	WASHER M4 SPRING	REAR TERMINAL PCB FIXING
20063-0010	SCREW No.6 x 3/8 NIB HDPZ ST/AB	CASE
20065-0070	SCREW M2.5 x 6 PLAS PNHDPZ	BEZEL FIXING
20210-0101	NUT M3 ZPST	CHASSIS/FRONT PANEL
20210-0110	NUT M4 BARB	SAFETY EARTH
20210-0111	NUT M4 SERRATED FLANGE	EARTH TERMINAL
20210-0130	NUT M6 BARB ZPST	POWER PCB OUTPUT
20213-0040	CAPTIVE NUT SPIRE No.6	CASE UPPER/CHASSIS REAR PANEL
20234-0016	SCREW M4 x 16 PNHDPZ ZPST	BACK FEET
20234-0023	SCREW M4 x 8 PNHDPZ ZPST	REAR TERMINAL PCB FIXING
20234-0028	SCREW M4 x 10 PNHDPZ ZPST	FRONT FEET
20234-0100	SCREW M3 x 6PNHDPZ C/W EXT SH/PROOF	KEYBOARD/CONTROL PCB POWER PCB/CHASSIS PFC PCB/CHASSIS WIRE SUPPORT BRACKET CHASSIS/REAR PANEL CHASSIS/FRONT PANEL
20236-0010	SCREW M4 x 12 TAMPERPROOF	SAFETY EARTH
22443-0002	GROMMET - 3109A	WIRE SUPPORT BRACKET
22571-1101	WASHER ALUMINIUM EARTH TERMINAL	FOR FRONT PANEL EARTH

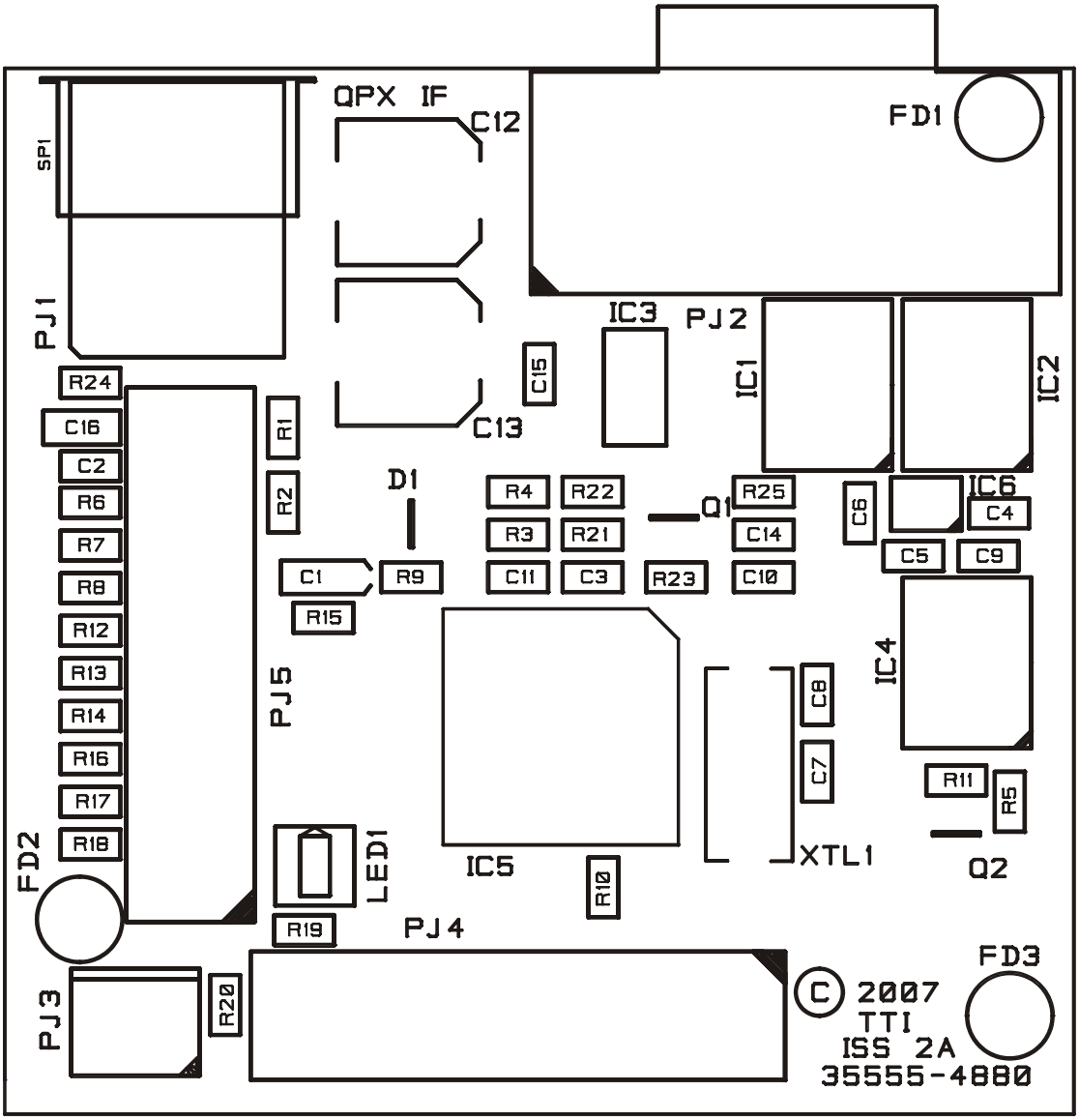
Component Layouts



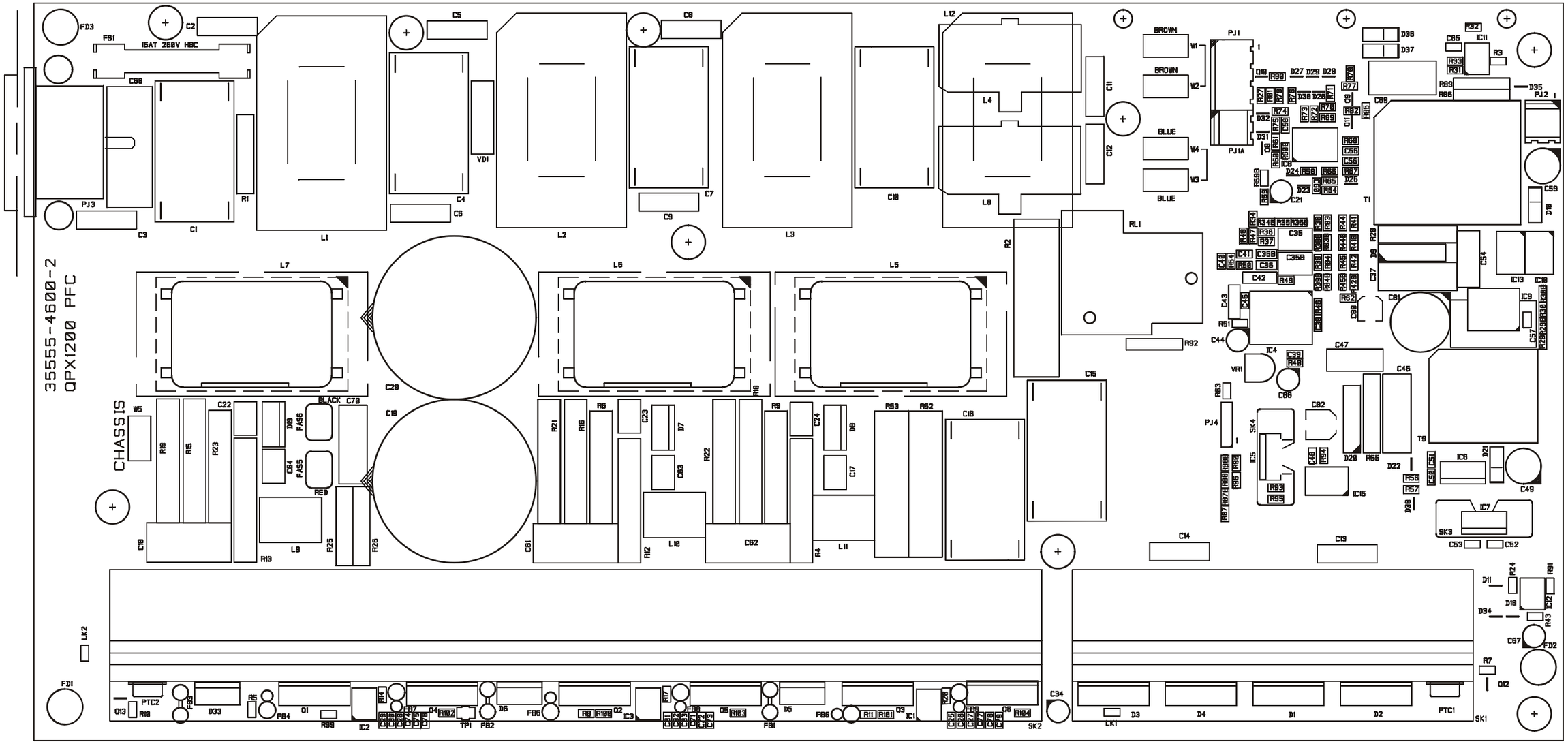
QPX1200 KEYBOARD PCB



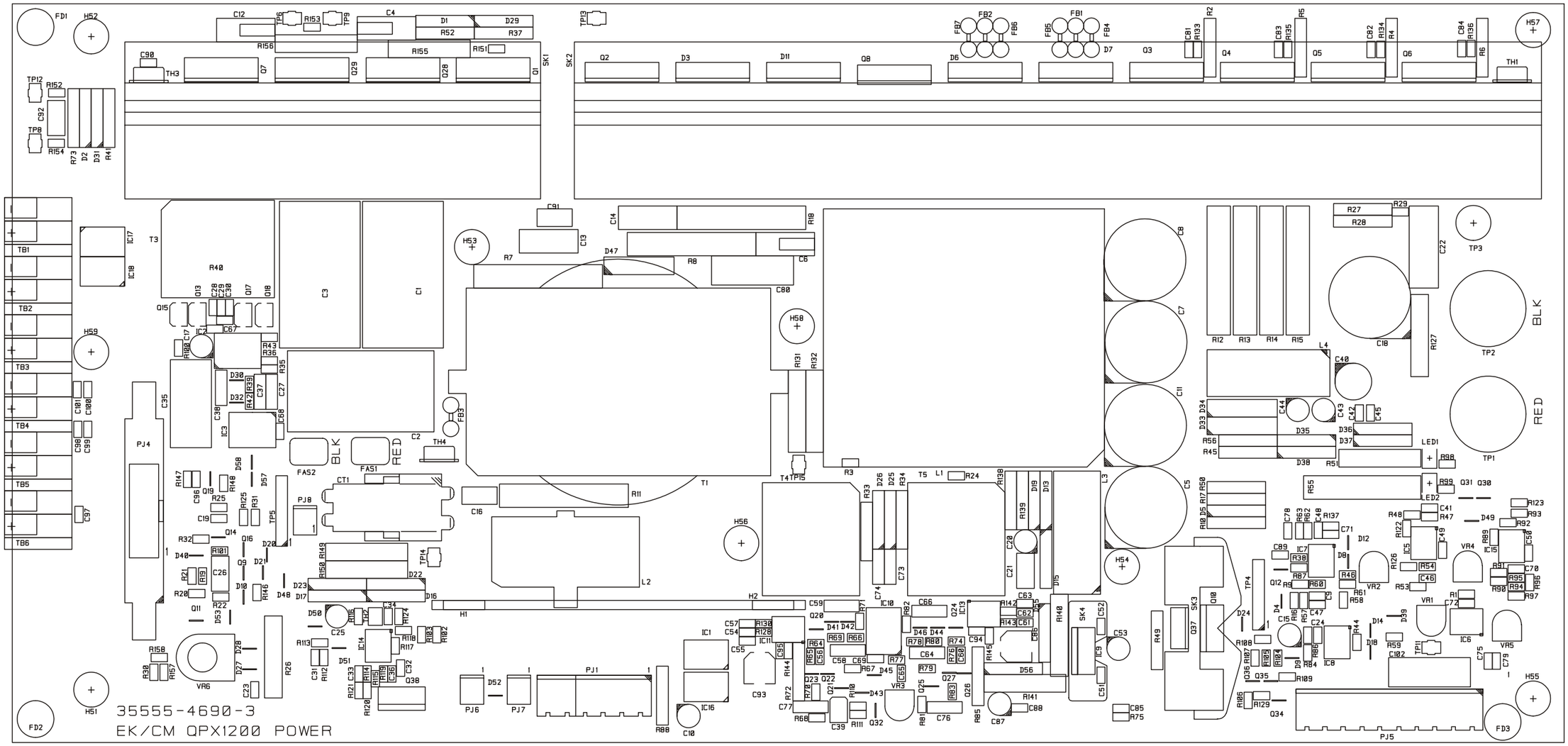
QPX1200 CONTROL PCB



INTERFACE ASSEMBLY

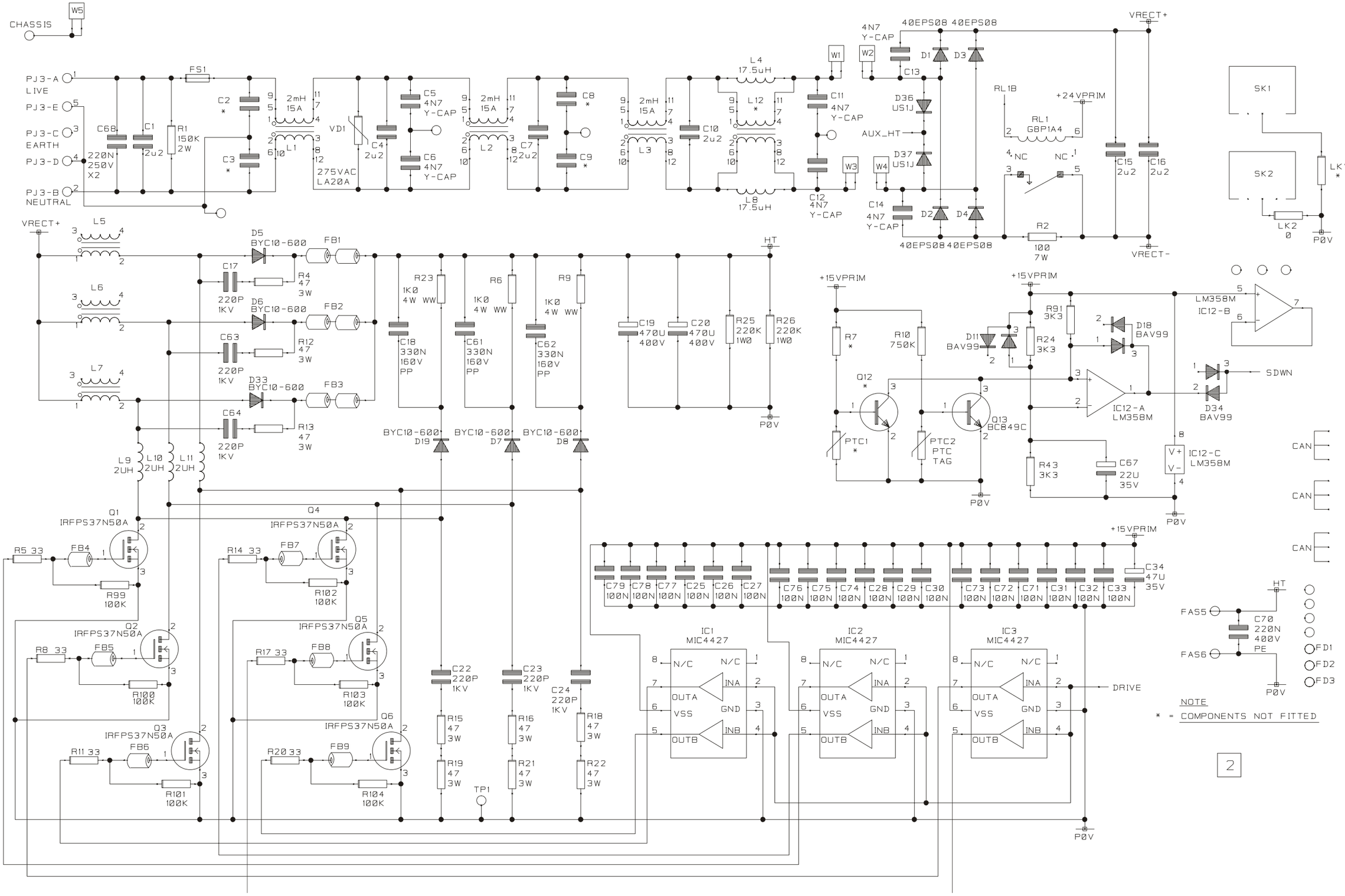


QPX1200 PFC PCB COMPONENT LAYOUT

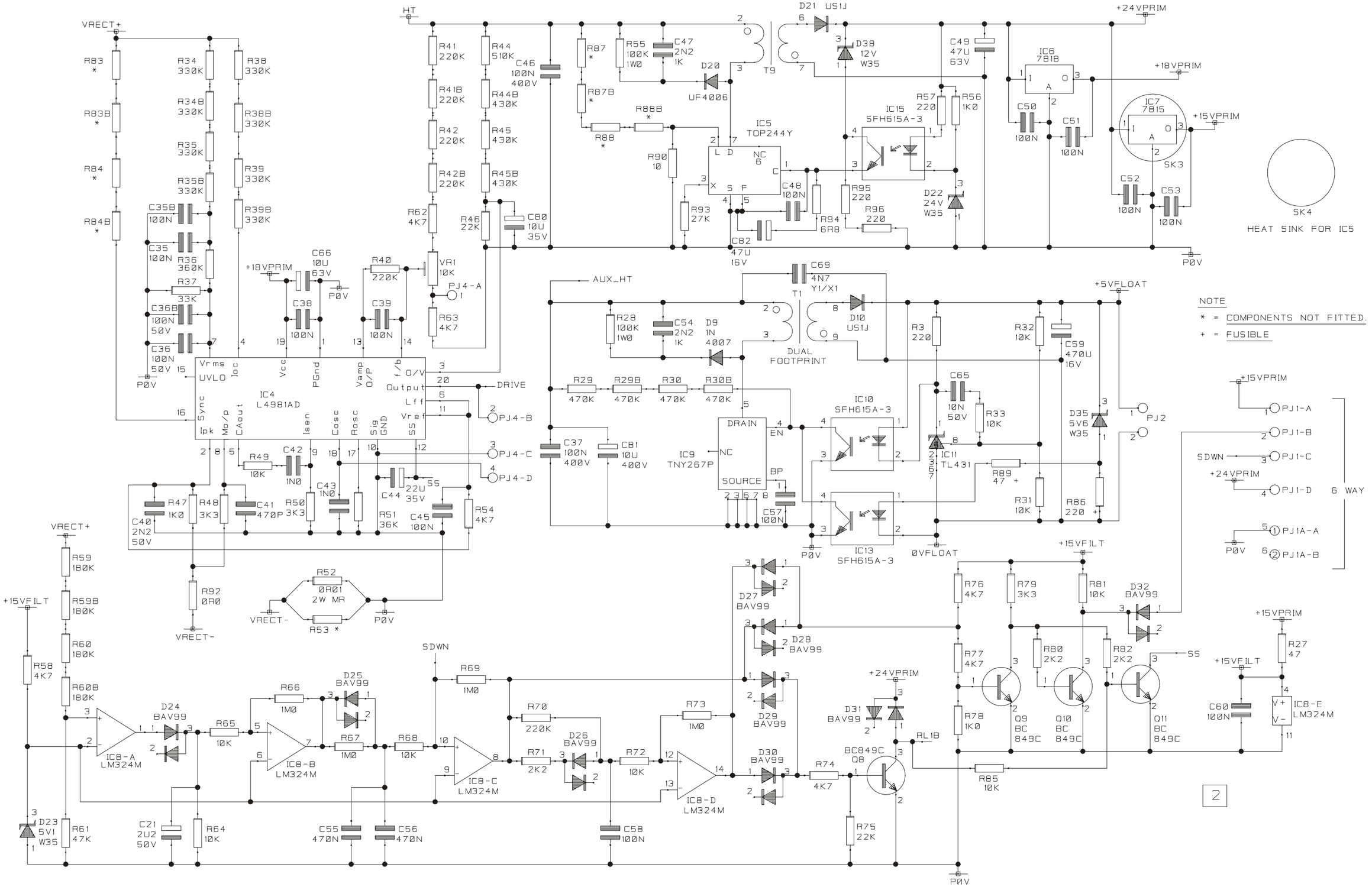


QPX1200 POWER PCB COMPONENT LAYOUT

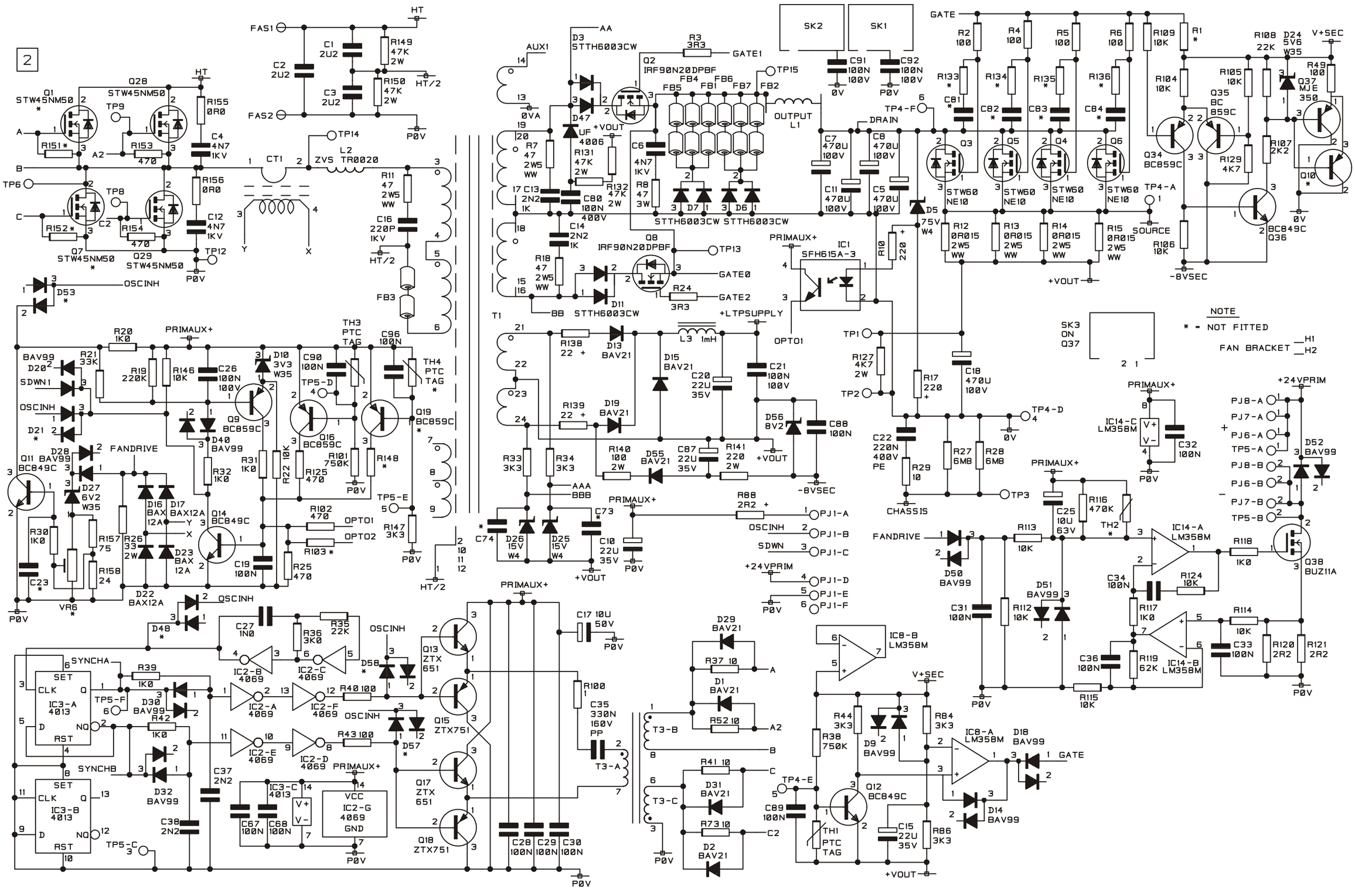
Circuit Diagrams



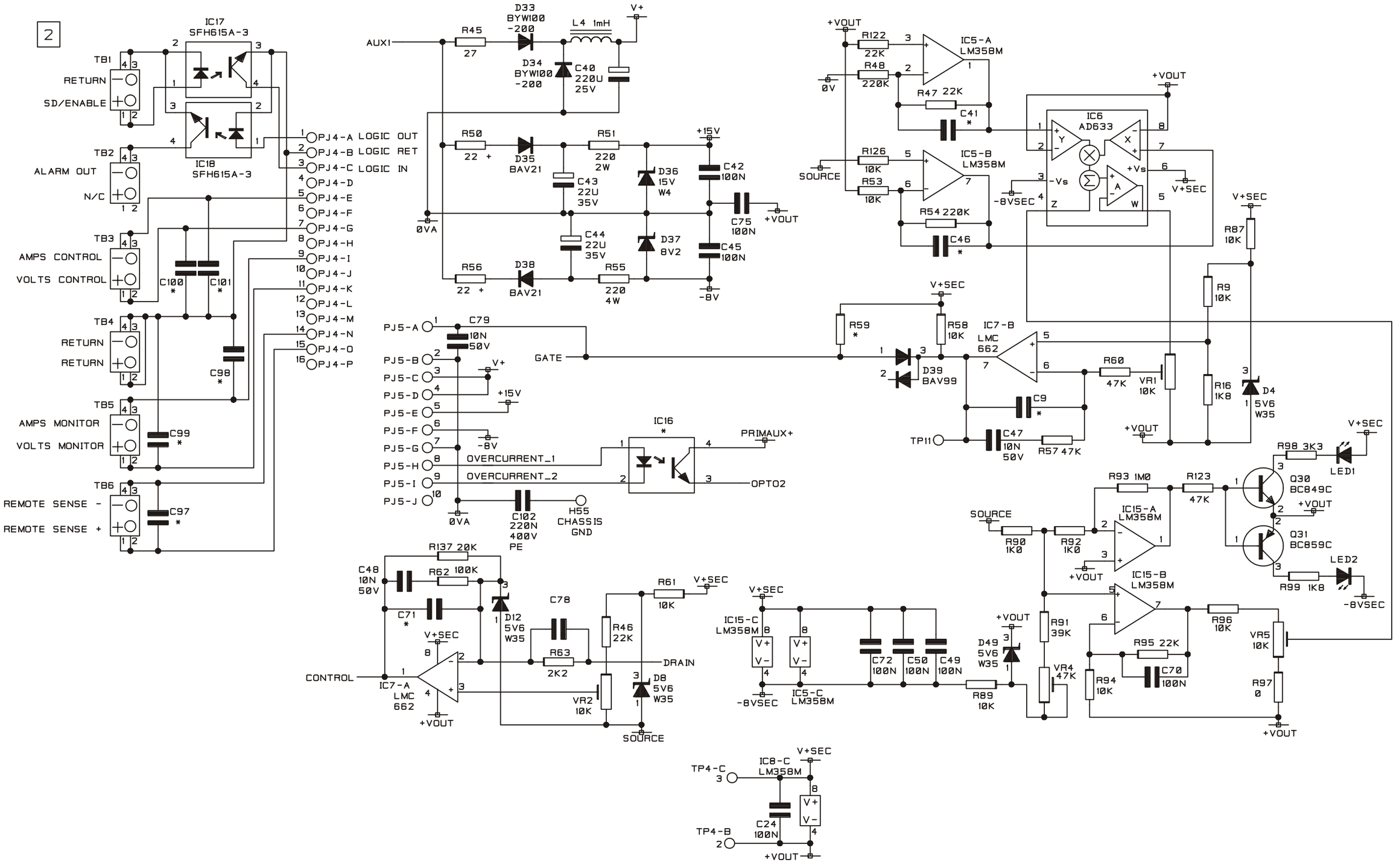
QPX1200 PFC PCB – Sheet 1 of 2



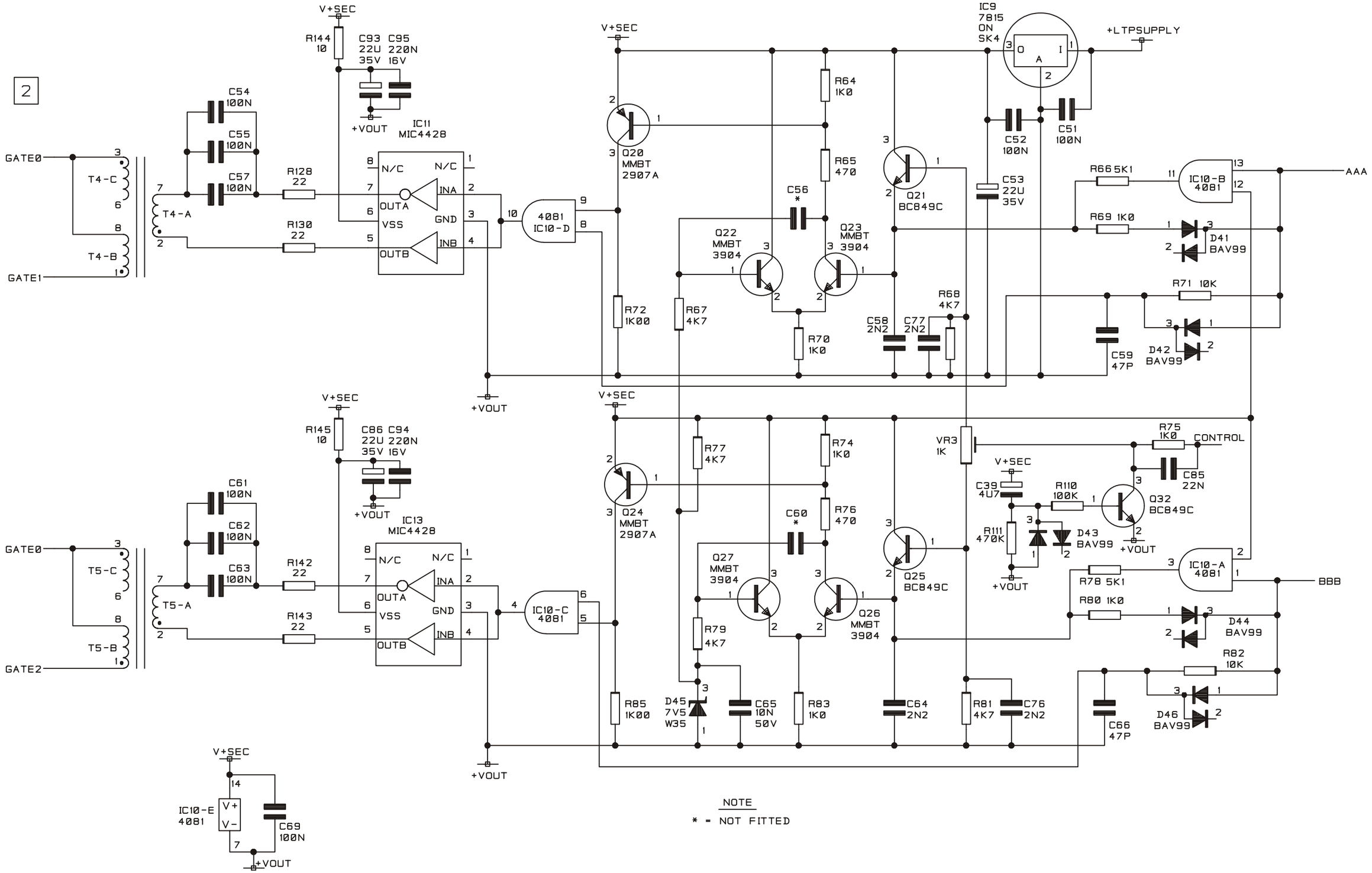
QPX1200 PFC PCB – Sheet 2 of 2



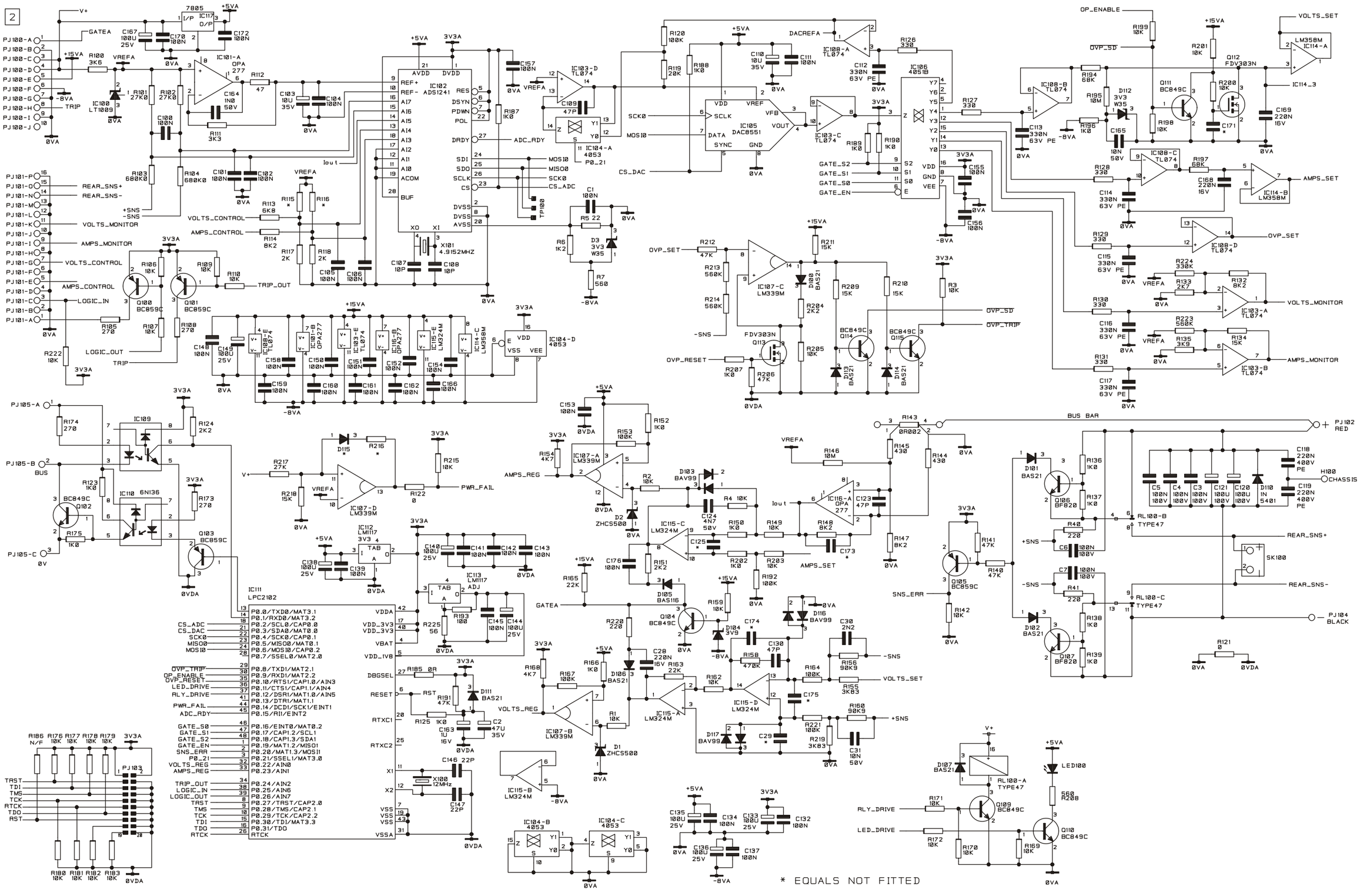
QPX1200 POWER PCB – Sheet 1 of 3



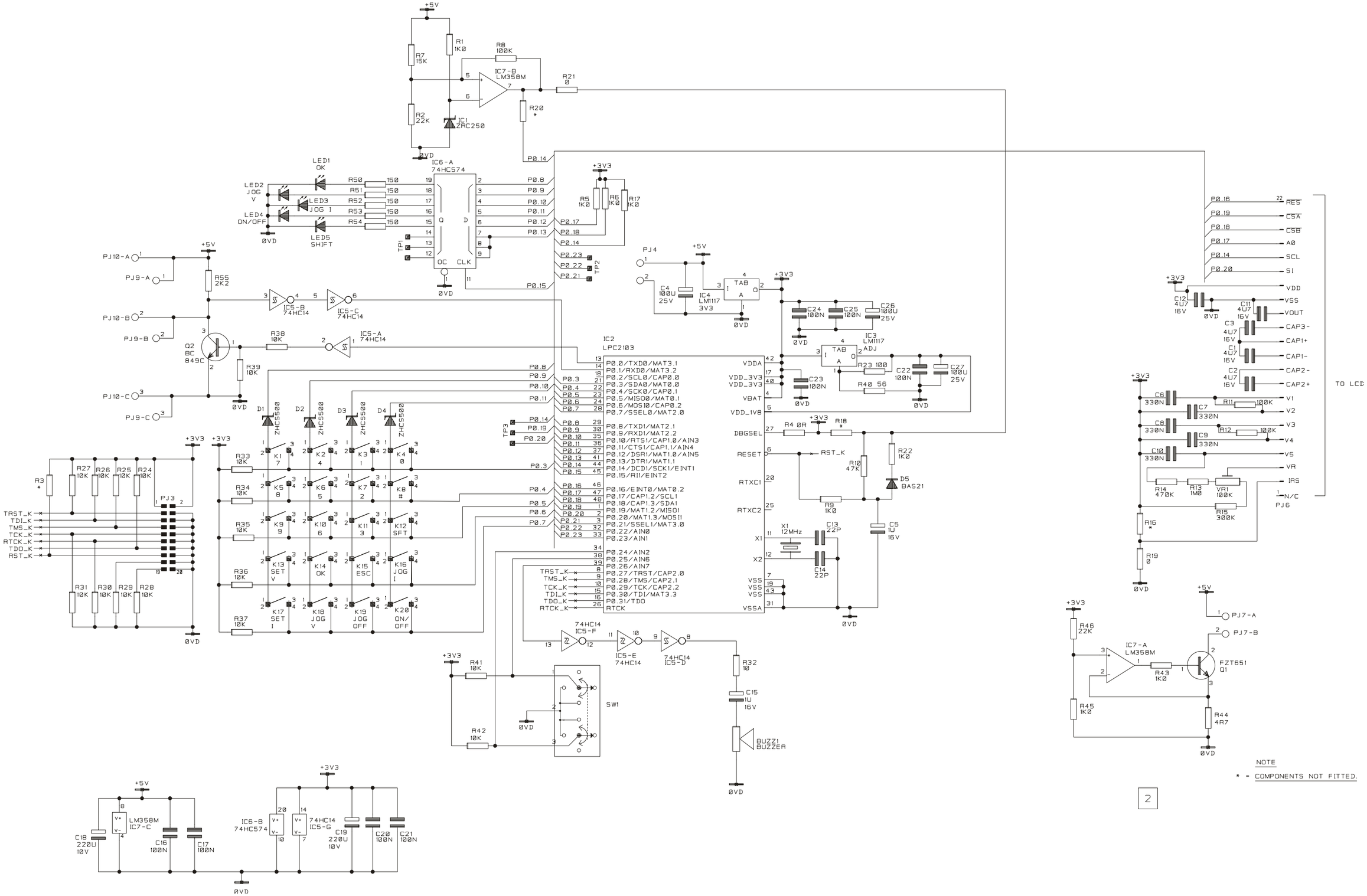
QPX1200 POWER PCB – Sheet 2 of 3



QPX1200 POWER PCB – Sheet 3 of 3



QPX1200 CONTROL PCB

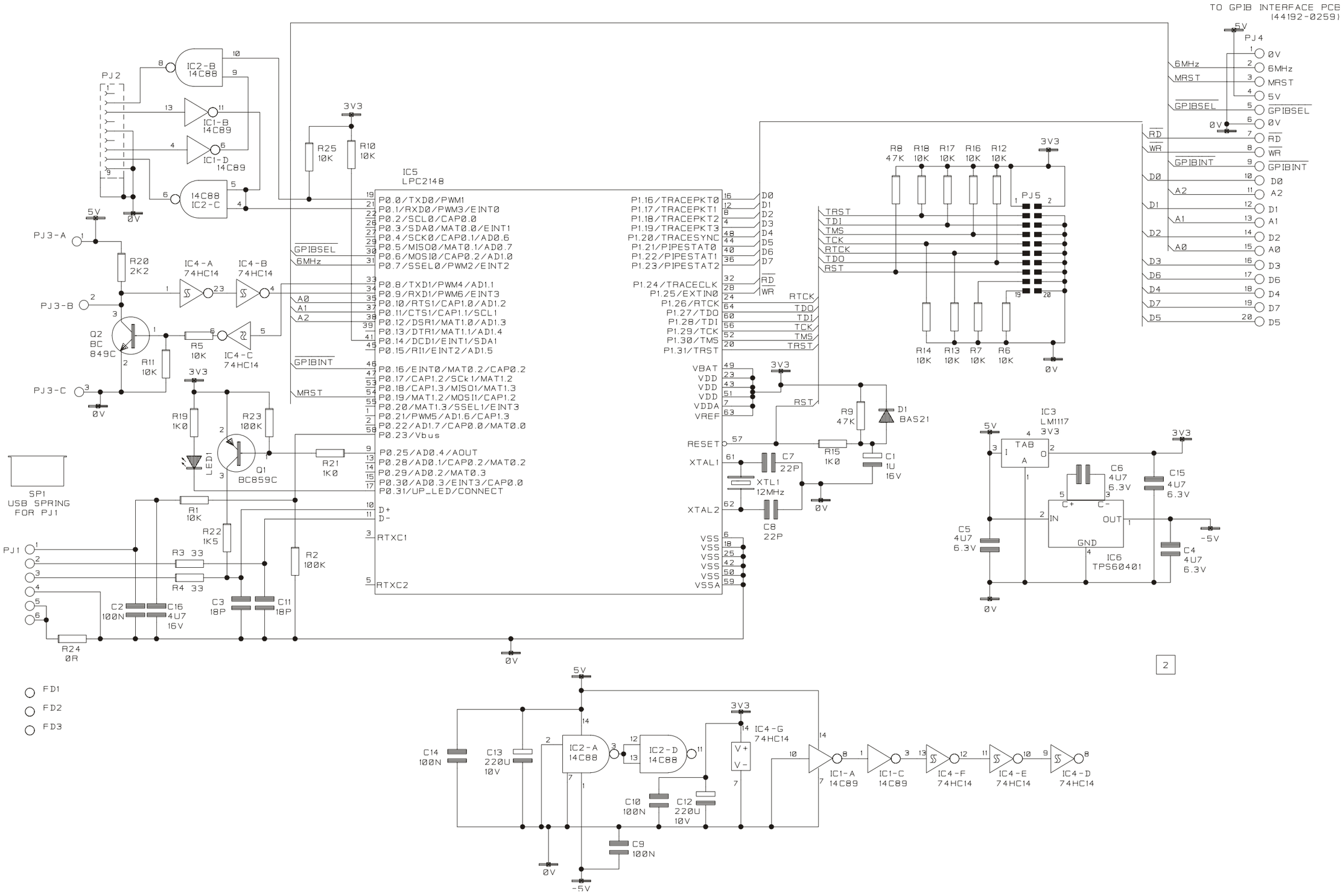


NOTE

* = COMPONENTS NOT FITTED.

2

QPX1200 KEYBOARD PCB



QPX1200 INTERFACE PCB

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